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DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK

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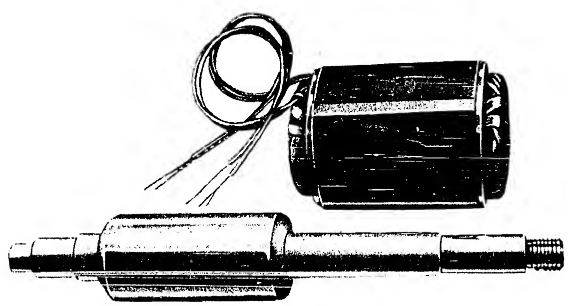


VEM MOUNTED THREE-PHASE MOTORS AND MOUNTED POLE-CHANGING MOTORS FOR THREE-PHASE CURRENT WITH SQUIRREL-CAGE ROTOR

Air draft cooling

Design A 1

Mounted three-phase motors and mounted pole-changing motors for three-phase current with squirrel-cage rotor

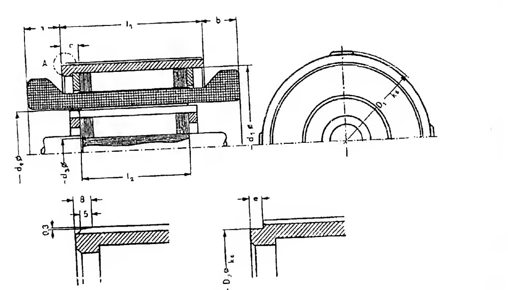
Anti-friction bearing, design A 1

Type EBM	Capacity kW	Capacity HP	Nominal speed rpm	Nom. current at 380 volts A	Efficiency %	Capacity factor cos φ	Weight about kg	Weight about lbs
Lost motion speed 3000 rpm.								
135/2	0,75	1	2800	2	80	0,79	8,8	19½
137/2	1,1	1,5	2810	2,7	78	0,8	10,6	23½
139/2	1,5	2	2840	3,2	80	0,82	12,7	28
169/2	2,2	3	2840	4,85	81,5	0,84	17,7	39
1611/2	3	4	2840	6,6	82	0,84	18,5	41
1616/2	4	5,5	2840	8,7	84	0,83	28,6	63
1811/2	4	5,5	2840	8,6	83	0,85	29,5	65
1816/2	6	8,1	2840	12,5	84	0,87	40,6	89
Lost motion speed 1500 rpm.								
137/4	0,55	0,75	1400	1,55	70	0,72	9,8	22
139/4	0,75	1	1400	2	75	0,73	11,8	26
167/4	1,1	1,5	1400	2,8	78,5	0,76	14	31
169/4	1,5	2	1400	3,55	80	0,8	16,5	36
188/4	2,2	3	1415	5	81	0,82	22,8	50
1811/4	3	4	1420	6,6	83	0,83	28,1	62
1816/4	4	5,5	1425	8,7	84	0,83	39,7	87
Lost motion speed 1000 rpm.								
167/6	0,65	0,9	910	2	71	0,7	14	31
169/6	0,88	1,2	915	2,48	74	0,73	16,5	36
188/6	1,5	2	920	3,9	76	0,75	22,8	50
1812/6	2,2	3	050	5,65	80	0,74	32,1	71

Eight-pole motors ond motors for discontinous service upon speciol request!

Pole-changing engines

Type EBM	Capacity kW	Capacity HP	Nominal speed rpm	Nom. current at 380 volts A	Efficiency %	Capacity factor cos φ	Weight about kg	Weight about lbs.
Lost motion speed 1500/3000 rpm								
139/4/2	0,6/0,8	0,8/1,1	1410/2840	2,85/3,83	75	0,75	11,8	26
167/4/2	0,8/1,1	1,1/1,5	1410/2840	3,35/4,65	79	0,8	14	31
169/4/2	1,1/1,5	1,5/2	1400/2830	4,5/6,1	79,5	0,81	16,5	36
188/4/2	1,8/2,2	2,5/3	1420/2850	7,5/8,7	79	0,81	22,8	50
1811/4/2	2,4/3	3,3/4	1430/2860	10/12	77	0,82	28,1	62
1816/4/2	3,5/4,2	4,8/5,7	1430/2860	13,3/14,8	82	0,83	39,7	87



Design 1 Design 2

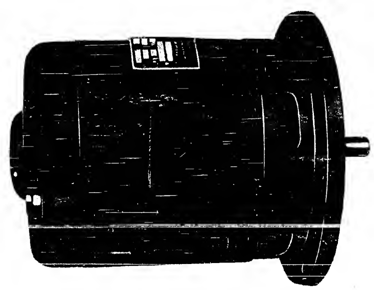
Meas. in mm

Type	a	b	c	e	l_1	l_2	$d_1 \varnothing$	$d_2 \varnothing$	$d_3 \varnothing$	$D_1 \varnothing$	$D_2 \varnothing$
135/2 137/2 137/4 137/4/2 139/2 139/4 139/4/2	30	30	15	5	80 100 100 100 120 120 120	50 70 70 70 90 90 90	135	75 75 90 90 75 90 90	24/40 2)	145	142
167/4 167/6 167/4/2 169/2 169/4 169/2 169/4/2 1611/2 1616/2	35	35	16	6	105 105 105 125 125 125 125 145 195	70 70 70 90 90 90 90 110 160	160	100 100 100 85 100 100 100 85 85	28/24 2)	175	168
188/4 188/6 188/8 188/4/2 1811/2 1811/4 1811/8 1811/4/2 1812/6 1816/2 1816/4 1816/8 1816/4/2	44	42	16	6	115 115 115 115 145 145 145 145 155 195 195 195 195	80 80 80 80 110 110 110 110 120 160 160 160 160	185	120 120 1) 120 100 120 1) 120 120 100 120 1) 120	35/50 2)	205	102

1) Still being prepared 2) Special design

All these types are mounted three-phase motors with squirrel-cage rotors of design A 1. Delivery includes a stator in the cast cylinder with winding, and rotor (squirrel-cage rotor type) with shaft, without anti-friction bearing and without wedge. Except the electrotechnical part — the rotor — the shaft will be delivered in accordance with purchaser's instructions. The size of the cast cylinder for the stator as well as that of the rotor depends on the capacity required. Concerning the construction of the shaft, please pay special attention to the seat of the rotor, which must be exactly upon the middle of the stator. Towards the drive side the rotor packet must lie closely against one of the collars, which, if possible, should be by 3 mm larger than the rotor bore. The rotor seat towards the empty side should be by 5 mm longer than the rotor packed. Sufficient tolerances for the dimensions of the shaft should be provided for with a sufficient clearance, taking account of a heating of the shaft which might occur. Detailed inquiries are indispensable due to the fact that the adequate type for the special case depends on the sort of cooling. In case of orders write for our questionary WN 72. These motors can also be delivered without cast ring. The power figures (capacity) stated in the table refer to continuous service at standard voltages of 220, 380 and 500 volts and at a frequency of 50 c.p.s. This also refers to the number of turns (speed).

The delivery also includes the terminals, the length of which depends on the position of the terminal box. As for the rest, both the insulation and the design answer the general regulations of the VDE (Association of German Electricians).



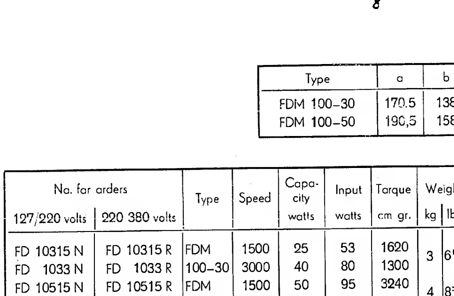
VEM FLANGE MOTORS

for three-phase current

Driving motors, agitators, blowers

Tension: 127/220 volts—220/380 volts
Capacity: 25—70 watts
Speed: 1500/3000 rpm

VEM Flange motors for three-phase current Type FDM 100 with ball bearings



Type	a	b
FDM 100–30	170.5	138
FDM 100–50	190,5	158

No. for orders		Type	Speed	Capa-city	Input	Torque	Weight	
127/220 volts	220 380 volts			watts	watts	cm gr.	kg	lbs.
FD 10315 N	FD 10315 R	FDM	1500	25	53	1620	3	6½
FD 1033 N	FD 1033 R	100–30	3000	40	80	1300		
FD 10515 N	FD 10515 R	FDM	1500	50	95	3240	4	8¾
FD 1053 N	FD 1053 R	100–50	3000	70	110	2270		

Meas. without engagement Capacity figures ± 10 % Speed —15 %

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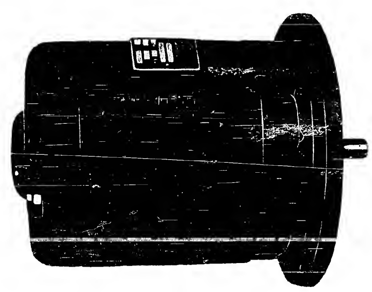

VEM FLANGE MOTORS

for three-phase current

Driving motors, agitators, blowers

Tension: 127/220 volts–220/380 volts

Capacity: 95–220 watts

Speed: 1500/3000 rpm

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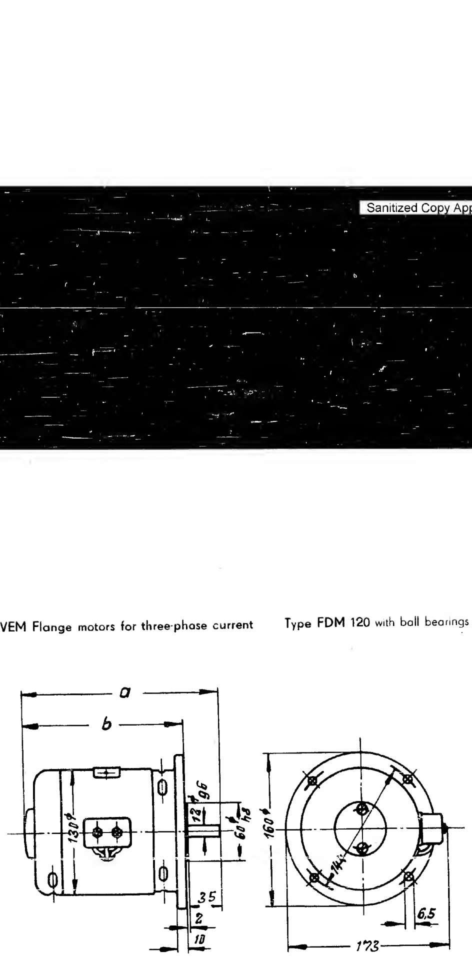
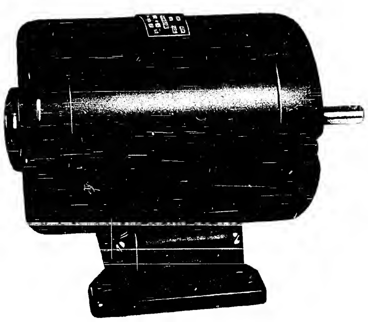
VEM Flange motors for three-phase current   Type FDM 120 with ball bearings



Type	a	b
FDM 120–40	208	171
FDM 120–60	228	191

No. for orders		Type	Speed	Capacity	Input	Torque	Weight	
127/220 volts	220/380 volts			watts	watts	cm gr	kg	lbs.
FDK 12415 N	FDK 12415 R	FDM	1500	95	150	6160	6,8	15
FDK 1243 N	FDK 1243 R	120–40	3000	155	250	5000		
FDK 12615 N	FDK 12615 R	FDM	1500	165	260	10700	8,1	18
FDK 1263 N	FDK 1263 R	120–60	3000	220	340	7100		

Meas. without engagement   Capacity figures ± 10 %   Speed — 15 %



VEM CASING MOTORS

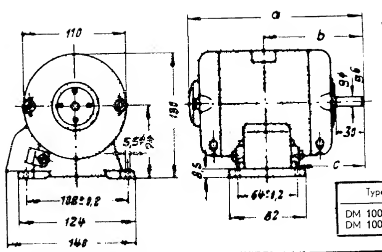
for three-phase current

Tension: 127/220 volts–220/380 volts

Capacity: 25–220 watts

Speed: 1500/3000 rpm

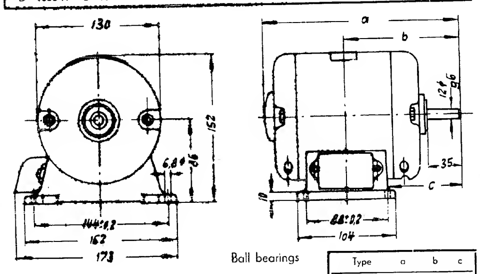
VEM Three-phase motors



Ball bearings

Type	a	b	c
DM 100–30	171	96	64
DM 100–50	191	106	74

No. for orders 127/220 volts	220/380 volts	Type	Speed	Capacity watts	Input watts	Torque cm g	Weight kg	lbs.
D 10315 N D 1033 N	D 10315 R D 1033 R	DM 100–30	1500 3000	25 40	53 80	1620 1300	3,2	7
D 10515 N D 1053 N	D 10515 R D 1053 R	DM 100–50	1500 3000	50 70	95 110	3240 2270	4,1	9

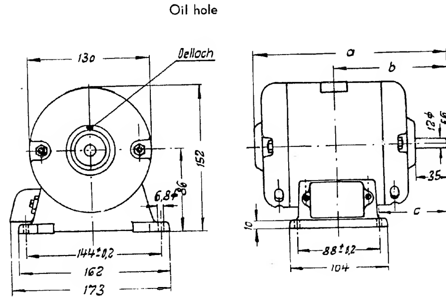


Ball bearings

Type	a	b	c
DM 120–40	208,5	120,5	76,5
DM 120–60	228,5	130,5	86,5

No. for orders 127/220 volts	220/380 volts	Type	Speed	Capacity watts	Input watts	Torque cm g	Weight kg	lbs.
DK 12415 N DK 1243 N	DK 12415 R DK 1243 R	DM 120–40	1500 3000	95 155	150 250	6160 5000	7	15
DK 12615 N DK 1263 N	DK 12615 R DK 1263 R	DM 120–60	1500 3000	155 220	260 340	10700 7100	8,3	18¼

Oil hole



Friction bearings

Type	a	b	c
DM 120–40	205	120	76
DM 120–60	225	130	86

No. for Orders 127/220 volts	220/380 volts	Type	Speed	Capacity watts	Input watts	Torque cm g	Weight kg	lbs.
DG 12415 N DG 1243 N	DG 12415 R DG 1243 R	DM 120–40	1500 3000	95 155	150 250	6160 5000	7	15
DG 12615 N DG 1263 N	DG 12615 R DG 1263 R	DM 120–60	1500 3000	165 220	260 340	10700 7100	8,3	18¼

Meas without engagement

Capacity figures $\pm 10\%$ Speed -15%

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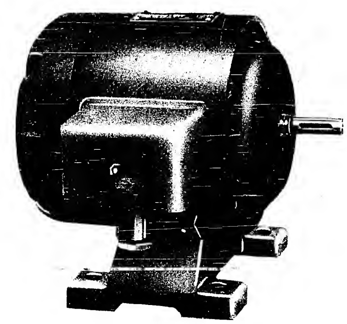
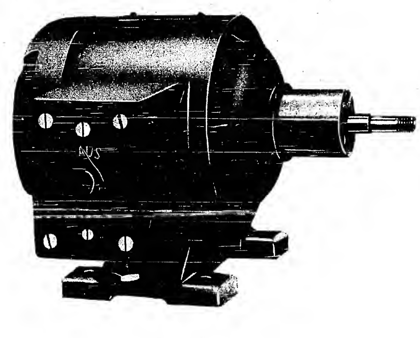


VEM THREE-PHASE MOTOR WITH SQUIRREL-CAGE ROTOR

Design B 3 Style of enclosure P 33

Type	Capacity kW	Speed rpm	Nom. current at 380 volts A	Efficiency %	Capacity factor cos φ	Weight about kg	lbs.
ODK 0,15/2	0,15	2800	0,4	0,62	0,78	5	11

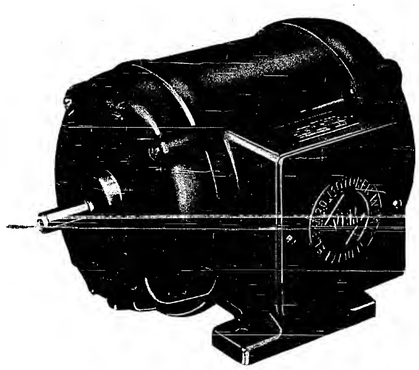


**VEM THREE-PHASE MOTOR
WITH SQUIRREL-CAGE ROTOR**

Design B 3 Style of enclosure P 33

with push-button switch and extended shaft stump on separate supports for grinding wheels

Type	Capacity kW	Speed rpm	Nom. current at 380 volts A	Efficiency %	Capacity factor cos φ	Weight about kg	Weight about lbs.
ODK 0,15/2 spec.	0,15	2800	0,4	0,62	0,78	5,5	12



**VEM THREE-PHASE MOTOR
WITH SQUIRREL-CAGE ROTOR**

Style of enclosure P 21

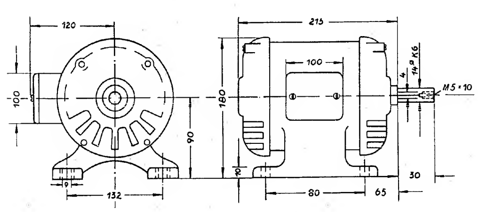
Designs B 3, B 6, B 8, V 6

Three-phase motor with squirrel-cage rotor

Style of enclosure: P 21

Anti-friction bearings. Designs: B 3, B 6, B 8, V 6, free shaft stump

Type	Capacity kW	Speed rpm	Nominal current at 380 volts A	Efficiency %	Capacity factor cos φ	Weight about kg	Weight about lbs.
Lost motion speed 3000 rpm							
D 120/2	0,37	2750	0,98	0,7	0,82	11	24
D 130/2	0,56	2760	1,38	0,77	0,84	13	28
Lost motion speed 1500 rpm							
D 120/4	0,25	1380	0,73	0,73	0,72	11	24
D 130/4	0,37	1390	1	0,75	0,76	13	28
Lost motion speed 1000 rpm							
D 120/6	0,125	890	0,45	0,61	0,65	11	24
D 130/6	0,2	900	0,7	0,65	0,66	13	28



The above stated types are three-phase motors with high-rod squirrel-cage rotors. Casing and bearing plates of grey cast iron. Ventilation by air draft, independent of the direction of rotation.

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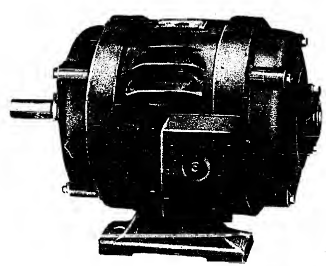
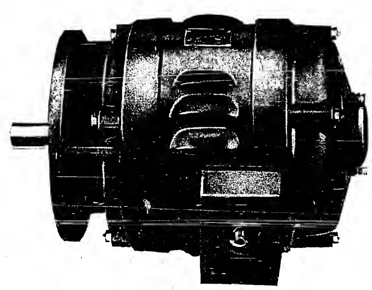




Sachsenwerk-THREE-PHASE MOTORS WITH SQUIRREL-CAGE ROTORS

Radeberg

Style of enclosure P 21, drip-proof

Designs B 3 and B 5

The three-phase motors answer the
"Rules for electric engines REM"
according to DIN 57530, ball bearings with grease lubrication.

Voltages: 220/380 volts*) and 380 V △, 500 volts at 50 rpm

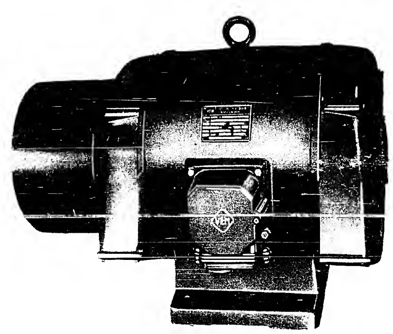
Speed (last motion): 3000, 1500, 1000 c.p.s.
2,3 to 2,5-fold starting torque at direct switching and
5 to 6,4-fold starting current.

Designs B 3 and B 5 can be used in any position, also vertically, however without any additional axial load. With normal free shaft end; designs with a 2nd shaft end only deliverable for more substantial orders.

Stator and rotor windings: Copper wire with varnish insulation, larger motors with varnish silk insulation

Power ranges: 1–10 kW at 3000 rpm
0,63–13 kW at 1500 rpm
0,37– 8 kW at 1000 rpm

*) 380 V △ only available for more than 4 kW



VEM THREE-PHASE SPECIAL GROOVE MOTORS WITH SQUIRREL-CAGE ROTORS

Style of enclosure: P 12, splash-proof

Designs: B 3 and B 5

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Three-phase special groove motors with squirrel-cage rotor

Style of enclosure: P 12, splash-proof
Anti-friction bearing, designs B 3 and B 5
Free shaft end

Type	Capacity kW	Capacity HP	Speed abt. rpm	Nominal current at 380 volts about amp.	Efficiency about %	Capacity factor cos φ about	Weight about kg	Weight about lbs
Last motion speed 3000 rpm								
LK 22/2	2,2	3	2800	5,05	79	0,84	17,5	38½
LK 27/2	3	4	2810	6,7	80	0,85	20	44
LK 32/2	4	5,5	2840	8,7	82	0,85	29	64
LK 37/2	5,5	7,5	2850	11,7	83	0,86	34	75
LK 42/2	7,5	10	2860	15,6	84	0,87	48	106
LK 47/2	10	13,6	2880	20,5	85	0,87	52	114
SK 52/2	15	20	2890	30	86	0,88	85	187
SK 55/2	20	27	2900	40	86,5	0,88	92	202
Last motion speed 1500 rpm								
LK 22/4	1,5	2	1390	3,65	77	0,81	17,5	38½
LK 27/4	2,2	3	1390	5,1	80	0,82	20	44
LK 32/4	3	4	1410	6,75	81	0,83	29	64
LK 37/4	4	5,5	1415	8,8	83	0,83	34	75
LK 42/4	5,5	7,5	1415	11,8	84	0,84	48	106
LK 47/4	7,5	10	1415	15,8	85	0,85	52	114
SK 52/4	9,2	12,5	1420	19,2	85,5	0,85	85	187
SK 55/4	11	15	1425	22,8	86	0,85	92	202

Standard voltages 220, 380 or 500 volts, 50 c.p.s. In case of other voltages and frequencies please write for the corresponding dates.
The motors shown here can also be delivered for vertical mounting (which must be mentioned in your order). In this case the stress of the bearings in the axial direction must restrict itself to the weight of the rotor.

Three-phase special groove motors with squirrel-cage rotor

Style of enclosure: P 12, splash proof
Anti-friction bearing, designs B 3 and B 5
Free shaft end

Type	Capacity kW	Capacity HP	Speed abt. rpm	Nominal current at 380 volts about amp.	Efficiency about %	Capacity factor cos φ about	Weight about kg	Weight about lbs.
Last motion speed 1000 rpm								
LK 22/6	0,8	1,1	920	2,3	72	0,74	17,5	38½
LK 27/6	1,1	1,5	920	3,1	72,5	0,75	20	44
LK 32/6	1,5	2	920	3,9	75,5	0,77	29	64
LK 37/6	2	2,75	920	5,1	77	0,78	34	75
LK 42/6	3	4	930	7,3	79	0,79	48	106
LK 47/6	3,7	5	930	8,8	80,5	0,80	52	114
SK 52/6	5,5	7,5	930	12,5	82,5	0,81	85	187
SK 55/6	8	11	935	17,6	84	0,82	92	202
Last motion speed 750 rpm								
LK 22/8	0,44	0,6	680	1,57	64,5	0,66	17,5	38½
LK 27/8	0,55	0,75	680	1,89	66	0,67	20	44
LK 32/8	1	1,36	690	3,1	70	0,70	29	64
LK 37/8	1,4	1,9	690	4,05	72,5	0,72	34	75
LK 42/8	1,85	2,5	700	5,1	74	0,74	48	106
LK 47/8	2,2	3	700	5,9	76	0,75	52	114
SK 52/8	4	5,5	705	9,7	79,5	0,78	85	187
SK 55/6	5	6,8	705	11,7	81	0,80	92	202

Standard voltages 220, 380 or 500 volts, 50 c.p.s. In case of other voltages and frequencies please write for the corresponding dates.
The motors shown here can also be delivered for vertical mounting (which must be mentioned in your order). In this case the stress of the bearings in the axial direction must restrict itself to the weight of the rotor.

Up to size 37 the motors are delivered without bearing eyes

For motors with two shaft ends the dimensions of the counter side are equal to those of the drive side

Mounting of the tension rails following this draft

Dimensions in mm, without engagement													Tension rails									
Type	a	b	c	d	e	f	g	g_1	h	h_1	i		H	M	N	Q	R	T	V	X	Y	
22	115	180	20	22	150	220	208	220	112	–	142		38	60	325	50	360	150	80	M 12	120	
27	135	180	20	22	170	220	208	220	112	–	142		38	60	325	50	360	150	80	M 12	120	
32	140	220	22	28	180	260	250	260	140	–	175		42	65	385	50	415	150	90	M 12	120	
37	165	220	22	28	205	260	250	260	140	–	175		42	65	385	50	415	150	90	M 12	120	
42	150	250	25	32	200	300	285	300	160	150	218		45	70	430	50	470	150	100	M 12	150	
47	180	250	25	32	230	300	285	300	160	150	218		45	70	430	50	470	150	100	M 12	150	
52	170	320	30	35	230	370	335	365	200	150	245		46	72	590	80	630	400	110	M 16	150	
55	210	320	30	38	270	370	335	365	200	150	250		46	72	590	80	630	400	110	M 16	150	

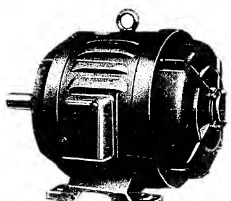
Fit of the counter piece: H 7   Fit of the shaft stumps: k 6

Up to size 37 the motors are delivered without bearing eyes

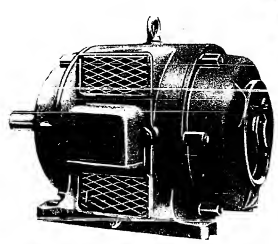
Dimensions in mm, without engagement																						
Type	a	b	c	d	e	f	g		i	k	l	o	p	q	s	t	u	w		r		
22	250	180	10	22	215	4	208		44	327	50	128	250	199	18	24,5	6	58		Pg 21		
27	250	180	10	22	215	4	208		44	347	50	138	250	209	18	24,5	6	58		Pg 21		
32	250	180	12	28	215	4	250		57	400	60	155	250	245	18	31	8	58		Pg 21		
37	250	180	12	28	215	4	250		57	426	60	168	250	258	18	31	8	58		Pg 21		
42	250	180	12	32	215	4	285		67	476	85	183	310	293	18	35,5	10	100		Pg 21		
47	250	180	12	32	215	4	285		67	506	85	198	310	308	18	35,5	10	100		Pg 21		
52	350	250	15	35	300	4	335		80	542	90	212	300	330	18	38,5	10	100		Pg 21		
55	350	250	15	38	300	4	335		85	587	95	232	390	355	18	41,5	10	100		Pg 21		

Fit of the counter piece: H 7   Fit of the shaft stumps: up to 45 ∅ k 6, more than 45 ∅ m 6

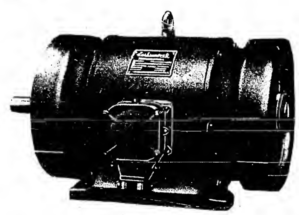
DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



Types D 65 and 66
Style of enclosure P 21



Types D 75 . . 96
Style of enclosure P 21



Style of enclosure P 22
Types D 105 . . . 117

Sachsenwerk - THREE-PHASE MOTORS WITH SQUIRREL-CAGE ROTORS

Niedersedlitz

Style of enclosure P 21 and P 22

Design B 3

1 — a 1.29

Three-phase motors with squirrel-cage rotors

Style of enclosure: P 21 up to size 96, terminal covering P 22
P 22 from size 105 upward, terminal covering P 43
Anti-friction bearing, design B 3, free shaft stump

Type	Capacity kW	Speed rpm	Nominal current at 380 volts A	Efficiency %	Capacity factor cos φ	Weight about kg	Weight about Cwts.
Last motion speed 1500 rpm. Starting torque 1,8 ... 2,5 fold Starting current 5,5 ... 6,5 fold							
D 65–4	18	1435	37,5	86,5	0,85	144	3.0.0
D 66–4	24	1435	49,5	87	0,85	173	3.2.0
D 75–4	34	1445	68,5	88	0,86	310	6.1.0
D 76–4	42	1445	84	88,5	0,86	360	7.1.0
D 85–4	55	1450	108	89	0,87	420	8.2.0
D 86–4	70	1455	136	90	0,87	430	8.2.0
D 95–4	100	1460	193	90,5	0,87	600	12.0.0
D 96–4	125	1460	240	91	0,87	680	13.2.0
D 105–4	160	1465	302	91,5	0,88	1035	20.2.0
D 106–4	200	1465	376	92	0,88	1205	24.0.0
D 107–4	250	1465	462	92,5	0,88	1385	27.0.0
D 115–4	320	1465	588	93	0,89	1695	33.1.0
D 116–4	400	1465	730	93,5	0,89	1940	38.0.0
D 117–4	500	1470	910	94	0,89	2220	44.0.0

From type D 95–4 upwards for direct coupling only

Three-phase motors with squirrel-cage rotors

Style of enclosure: P 21 up to size 96, terminal covering P 22
P 22 from size 105 upward, terminal covering P 43
Anti-friction bearing, design B 3, free shaft stump

Type	Capacity kW	Speed rpm	Nominal current at 380 volts A	Efficiency %	Capacity factor cos φ	Weight about kg	Weight about Cwts.
Last motion speed 1000 rpm. Starting torque 1,7 ... 2,2 fold Starting current 5,2 ... 6,2 fold							
D 65–6	12	950	25,5	85	0,84	144	3.0.0
D 66–6	16	950	33,5	86	0,84	173	3.2.0
D 75–6	23	960	47,5	86,5	0,85	320	6.1.0
D 76–6	30	960	61,5	87,5	0,85	360	7.1.0
D 85–6	40	960	81,5	88	0,85	430	8.2.0
D 86–6	50	960	101	88,5	0,85	500	10.0.0
D 95–6	70	965	139	89	0,86	610	12.0.0
D 96–6	90	965	177	90	0,86	690	13.3.0
D 105–6	110	970	215	90,5	0,86	1035	20.2.0
D 106–6	135	970	260	91	0,87	1205	24.0.0
D 107–6	170	970	325	91,5	0,87	1385	27.0.0
D 115–6	220	975	418	92	0,87	1695	33.1.0
D 116–6	265	975	501	92,5	0,87	1940	38.1.0
D 117–6	330	975	615	93	0,88	2220	44.0.0

From type D 105–6 upwards for direct coupling only

Three-phase motors with squirrel-cage rotors

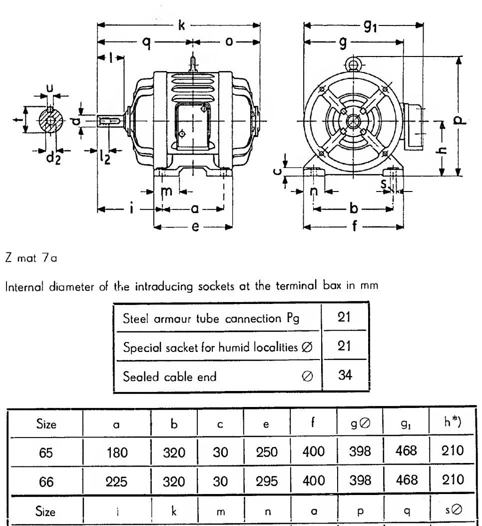
Style of enclosure: P 21 up to size 96, terminal covering P 22

P 22 fram size 105 upward, terminal covering P 43

Anti-frictian bearing, design B 3, free shaft stump

Type	Capacity kW	Speed rpm	Nominal current at 380 volts A	Efficiency %	Capacity factor cos φ	Weight about kg	Weight about Cwts.
Lost motion speed 750 rpm Starting torque 1,6 . . . 2 fold Starting current 4,8 . . . 5,8 fold							
D 65–8	8	710	18	83,5	0,80	154	3.0.0
D 66–8	12	710	27	84,5	0,81	183	3.3.0
D 75–8	18	710	40	85,5	0.81	340	6.3.0
D 76–8	22	715	48	86	0,81	385	7.3.0
D 85–8	30	715	65	86,5	0,82	450	9.0.0
D 86–8	37	715	78	87,5	0,83	520	10.1.0
D 95–8	50	720	104	88,5	0,83	655	11.0.0
D 96–8	64	720	130	89	0,84	740	14.2.0
D 105–8	80	730	162	89,5	0,84	1035	20.2.0
D 106–8	100	730	202	90	0,85	1205	24.0.0
D 107–8	125	730	247	90,5	0,86	1385	27.0.0
D 115–8	160	730	309	91,5	0,86	1695	33.1.0
D 116–8	200	730	385	92	0,86	1940	38.0.0
D 117–8	250	730	478	92,5	0,86	2220	44.0.0

From type D 115–8 upwards for direct caupling only



Z mat 7a

Internal diameter of the intraducing sockets at the terminal bax in mm

Steel armaur tube cannection Pg	21
Special sacket for humid localities ∅	21
Sealed cable end ∅	34

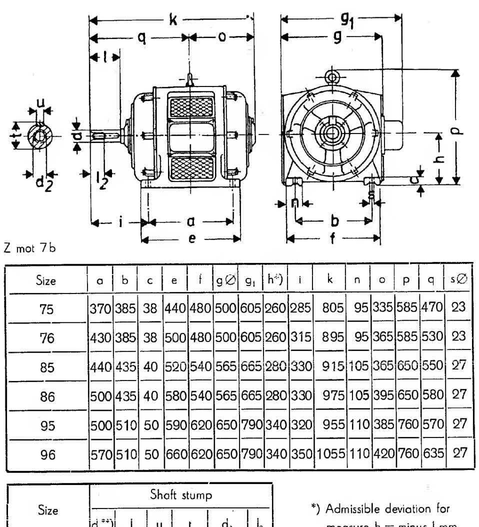
Size	a	b	c	e	f	g∅	g_1	h*)
65	180	320	30	250	400	398	468	210
66	225	320	30	295	400	398	468	210
Size	**i**	**k**	**m**	**n**	**o**	**p**	**q**	**s∅**
65	275	595	85	80	230	465	365	23
66	275,5	640	98	80	252	465	388	23

Size	Shaft stump					
	d**) ∅	l	t	u	d_2	l_2
65	45	110	48,5	14	M 16	45
66	45	110	48,5	14	M 16	45

*) Admissible deviation for measure h minus 0,5 mm

**) Fit: ISA k 6 accarding ta DIN 7160 sheet 3

Measures in mm



Z mot 7b

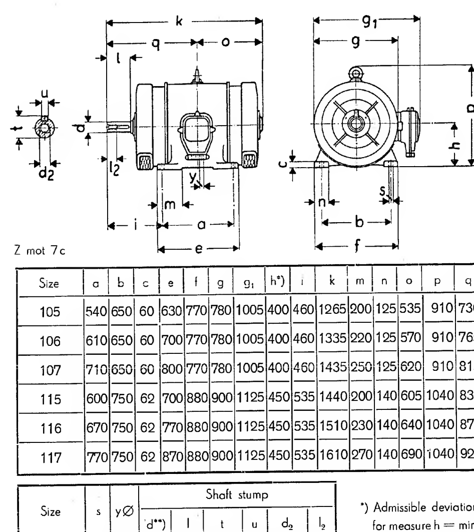
Size	a	b	c	e	f	g∅	g_1	h*)	i	k	n	o	p	q	s∅
75	370	385	38	440	480	500	605	260	285	805	95	335	585	470	23
76	430	385	38	500	480	500	605	260	315	895	95	365	585	530	23
85	440	435	40	520	540	565	665	280	330	915	105	365	650	550	27
86	500	435	40	580	540	565	665	280	330	975	105	395	650	580	27
95	500	510	50	590	620	650	790	340	320	955	110	385	760	570	27
96	570	510	50	660	620	650	790	340	350	1055	110	420	760	635	27

Size	Shaft stump					
	d**)	l	u	t	d_2	l_2
75	55	110	16	58,8	M 20	53
76	60	140	18	64,2	M 20	53
85	65	140	18	69,2	M 20	53
86	70	140	20	74,6	M 20	53
95	75	140	20	79,6	M 20	53
96	80	170	22	85,5	M 20	53

*) Admissible deviation for measure h = minus 1 mm ($^3/_{64}$ inch.)

**) Fit: ISA m 6 according to DIN 7160 sheet 3

Measures in mm



Z mot 7c

Size	a	b	c	e	f	g	g_1	h*)	i	k	m	n	o	p	q
105	540	650	60	630	770	780	1005	400	460	1265	200	125	535	910	730
106	610	650	60	700	770	780	1005	400	460	1335	220	125	570	910	765
107	710	650	60	800	770	780	1005	400	460	1435	250	125	620	910	815
115	600	750	62	700	880	900	1125	450	535	1440	200	140	605	1040	835
116	670	750	62	770	880	900	1125	450	535	1510	230	140	640	1040	870
117	770	750	62	870	880	900	1125	450	535	1610	270	140	690	1040	920

Size	s	y∅	Shaft stump					
			d**)	l	t	u	d_2	l_2
105	27	60	85	170	90,5	22	M 20	53
106	27	60	90	170	95,3	25	M 24	63
107	27	60	95	170	100,3	25	M 24	63
115	33	60	100	210	106,1	28	M 24	63
116	33	60	100	210	106,1	28	M 24	63
117	33	60	100	210	106,1	28	M 24	63

*) Admissible deviation for measure h = minus 1 mm ($^3/_{64}$ inch.)

**) Fit: ISA m 6 according to DIN 7160 sheet 3

Measures in mm

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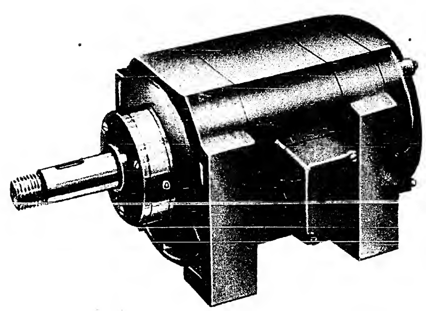


VEM THREE-PHASE MOTORS WITH SQUIRREL-CAGE ROTORS

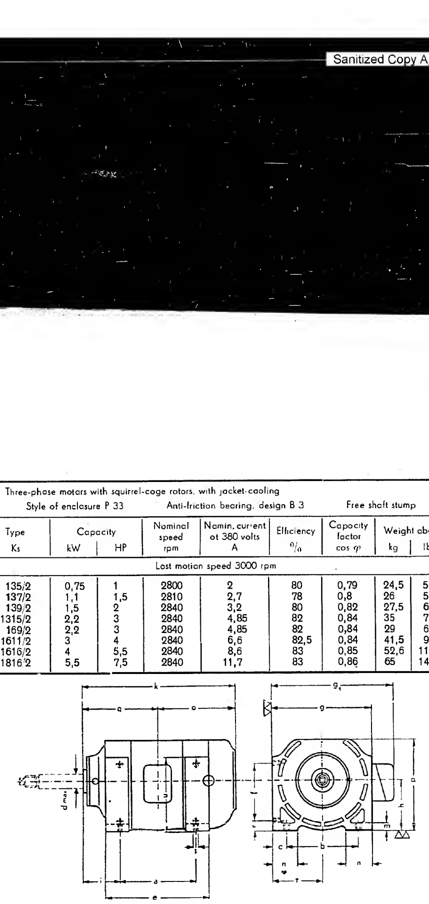
Jacket-cooling

Reinforced supports with machined mounting surfaces at the support plates

Design B 3

Style of enclosure: P 33

Three-phase motors with squirrel-cage rotors, with jacket-cooling. Style of enclosure P 33 · Anti-friction bearing, design B 3 · Free shaft stump								
Type Ks	Capacity kW	Capacity HP	Nominal speed rpm	Namin. current at 380 volts A	Efficiency %	Capacity factor cos φ	Weight about kg	Weight about lbs.
Last motion speed 3000 rpm								
135/2	0,75	1	2800	2	80	0,79	24,5	54
137/2	1,1	1,5	2810	2,7	78	0,8	26	57
139/2	1,5	2	2840	3,2	80	0,82	27,5	60½
1315/2	2,2	3	2840	4,85	82	0,84	35	77
169/2	2,2	3	2840	4,85	82	0,84	29	64
1611/2	3	4	2840	6,6	82,5	0,84	41,5	91
1616/2	4	5,5	2840	8,6	83	0,85	52,6	115
1816/2	5,5	7,5	2840	11,7	83	0,86	65	143



Type	a	b**)	c**)	d ∅	e	f*)	g	g1	h	i
135/2	117	137	22,5	32	166	95	181	225	90	69,5
137/2	117	137	22,5	32	166	95	181	225	90	69,5
139/2	137	137	22,5	32	186	95	181	225	90	69,5
1315/2	197	137	22,5	32	246	95	181	225	90	69,5
169/2	142	155	27,5	38	198	115	210	254	105	76,5
1611/2	162	155	27,5	38	218	115	210	254	105	76,5
1616/2	212	155	27,5	38	268	115	210	254	105	76,5
1816/2	223	187	32,5	38	278	130	252	301	125	76,5
Type	**k**	**m**	**n**	**o**	**p**	**q**	***)**	**s**	**t**	**u**
135/2	254	12	45	126	162	128	20	M 12	90	130
137/2	254	12	45	126	162	128	20	M 12	90	130
139/2	277	12	45	137	162	140	20	M 12	90	130
1315/2	334	12	45	166	162	168	20	M 12	90	130
169/2	304	16	55	153	192	151	25	M 12	104	156
1611/2	324	16	55	163	192	161	25	M 12	104	156
1616/2	374	16	55	188	192	186	25	M 12	104	156
1816/2	393	18	65	205	223	188	30	M 14	125	183

Design and delivery: outside the support plate the shaft can be delivered in any design.
*) Design 1: Lateral fastening.
**) Design 2: Foot fastening.

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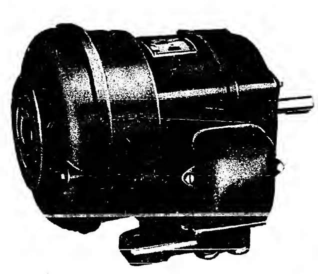

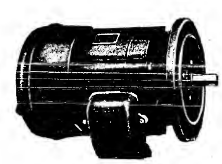

Sachsenwerk - THREE-PHASE CURRENT MOTORS WITH SQUIRREL-CAGE ROTORS

Radeberg

Style of enclosure P 33 closed, surface-cooled

Designs: B 3 and B 5

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The three-phase motors answer the
„Rules for electric engines REM" according to DIN 57530,
ball bearings with grease lubrication.

Voltages: 220/380 volts[*]), 380 volts △, 500 volts at 50 c. p. s.

Speed (lost motion): 3000, 1500, 1000 rpm

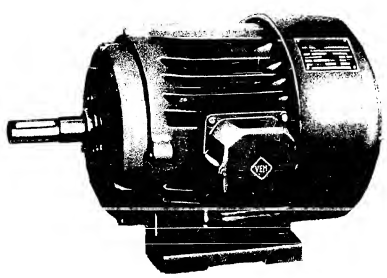
2,3 to 2,5-fold starting torque at direct switching and at 5 to 6,4-fold starting current. Designs B 3 and B 5 can be used in any position, even vertically, however without any additional axial load. With normal free shaft end, designs with a 2nd shaft end only deliverable for more substantial orders.

Stator and rotor winding:
copper wire with varnish insulation, larger motors with varnish silk insulation.

Power ranges:
1,5 to 8 kW at 3000 rpm
1,1 to 8 kW at 1500 rpm
0,6 to 5 kW at 1000 rpm

[*]) 380 volts △ available for more than 4 kW only

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



VEM THREE-PHASE CURRENT SPECIAL GROOVE MOTORS WITH SQUIRREL-CAGE ROTOR

Style of enclosure P 33, completely enclosed in a capsule, Jacket-cooling

Designs B 3 and B 5

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Three-phase current special groove motors with squirrel-cage rotor
completely enclosed in a capsule with jacket-cooling

Style of enclosure: P 33
Anti-friction bearing, designs B 3 and B 5
Free shaft end

Type	Capacity		Speed	Nominal current at 380 volts	Efficiency about	Capacity factor	Weight about	
	kW	HP	abt. rpm	about amp	%	cos φ abt.	kg	lbs.
Lost motion speed 3000 rpm								
LK 22/2 M	2,2	3	2820	4,9	80	0,86	21	46
LK 27/2 M	3	4	2830	6,5	82	0,87	26	57
LK 32/2 M	4	5,5	2850	8,2	84	0,88	36	79
LK 37/2 M	5,5	7,5	2860	11,3	84	0,88	42	92
LK 42/2 M	7	9,5	2870	14,1	85	0,91	57	125
LK 47/2 M	8,5	11,5	2880	17	85	0,91	66	145
SK 52/2 M	12	16,5	2900	22,7	86	0,92	90	198
SK 55/2 M	15	20	2910	28	86	0,92	107	235
Lost motion speed 1500 rpm								
LK 22/4 M	1,6	2,2	1420	3,8	79	0,8	21	46
LK 27/4 M	2,2	3	1420	5,1	80	0,82	26	57
LK 32/4 M	3	4	1430	6,7	81	0,84	36	79
LK 37/4 M	4	5,5	1430	8,9	81	0,84	42	92
LK 42/4 M	5,5	7,5	1430	11,7	83	0,86	57	125
LK 47/4 M	7,5	10	1430	15,5	83	0,86	66	145
SK 52/4 M	9,2	12,5	1440	19	84	0,87	90	198
SK 55/4 M	10	13,6	1440	20,8	84	0,87	107	235

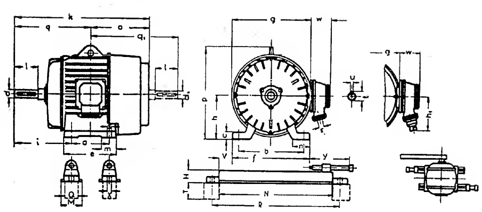
Standard voltages 220, 380 or 500 volts, 50 c. p. s. Other voltages and frequencies on special request (advance in price).
All motors of this list can also be delivered for vertical mounting (must be stated in the order). In this case the stress of the bearings in the axial direction must restrict itself to the weight of the rotor.

Three-phase current speciel groove motors with squirrel-cage rotor
completely enclosed in a capsule with jacket-cooling

Style of enclosure: P 33
Anti-friction bearing design B 3 and B 5
Free shaft end

Type	Capacity		Speed	Nominal current at 380 volts	Efficiency about	Capacity factor	Weight about	
	kW	HP	abt. rpm	about amp	%	cos φ abt.	kg	lbs.
Lost motion speed 1000 rpm								
LK 22/6 M	0,8	1,1	930	2,5	67	0,72	21	46
LK 27/6 M	1,1	1,5	930	3,2	71	0,73	26	57
LK 32/6 M	1,6	2,2	940	4,5	73	0,74	36	79
LK 37/6 M	2	2,7	940	5,5	75	0,74	42	92
LK 42/6 M	3	4	950	7,5	77	0,79	57	125
LK 47/6 M	4	5,5	950	9,8	78	0,79	66	145
SK 52/6 M	5,5	7,5	950	12,5	85	0,81	90	198
SK 55/6 M	7,5	10	950	16,1	86	0,82	107	235
Lost motion speed 750 rpm								
LK 22/8 M	0,4	0,55	690	1,7	60	0,6	21	46
LK 27/8 M	0,6	0,82	690	2,4	62	0,62	26	57
LK 32/8 M	1	1,36	700	3,2	69	0,68	36	79
LK 37/8 M	1,3	1,8	700	3,9	72	0,7	42	92
LK 42/8 M	1,8	2,5	710	5,1	76	0,7	57	125
LK 47/8 M	2,2	3	710	6	77	0,72	66	145
SK 52/8 M	4	5,5	710	10,2	81	0,73	90	198
SK 55/8 M	5	6,8	710	12,7	81	0,74	107	235

Standard voltages 220, 380 or 500 volts, 50 c. p. s. Other voltages and frequencies on special request (advance in price).
All motors of this list can also be delivered for vertical mounting (must be stated in the order). In this case the stress of the bearings in the axial direction must restrict itself to the weight of the rotor.



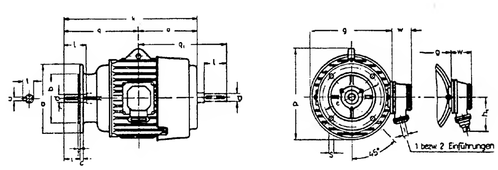
Up to size 37 the motors are delivered without bearing eyes

Mounting of the tension rails following this draft

The pulley for the 2nd shaft stump must not have a full disc, it must be fitted with spokes to enable a passing of the air to the shield bearing

	Meas. in mm without engagement													Tension rails								
Type	a	b	c	d	e	f	g	h	i	k	l	m	n	H	M	N	Q	R	T	V	X	Y
22/	115	180	20	22	150	220	235	112	142	362	50	45	45	38	60	325	50	360	150	80	15	120
27/	135	180	20	22	170	220	235	113	142	362	50	45	45	38	60	325	50	360	150	80	15	120
32/	140	220	22	28	180	260	275	140	175	435	60	50	60	42	65	385	50	417	150	90	15	120
37/	165	220	22	28	205	260	275	140	175	461	60	50	60	42	65	385	50	417	150	90	15	120
42/	150	250	25	32	200	300	300	160	219	508	85	55	70	45	70	430	50	470	150	100	15	150
47/	180	250	25	32	230	300	300	160	219	538	85	55	70	45	70	430	50	470	150	100	15	150
52/	170	320	30	35	230	370	360	200	245	573	90	60	80	46	75	590	80	630	400	110	20	150
55/	210	320	30	38	270	370	360	200	250	618	95	60	80	46	75	590	80	630	400	110	20	150

Fit of the counter piece H 7 Fit of the shaft stumps k 6



Up to size 37 the motors are delivered without bearing eyes

The pulley for the 2nd shaft stump must not have a full disc, it must be fitted with spokes to enable a passing of the air to the shield bearing

	Meas. in mm without engagement																			
Type	a	b	c	d	e	f	g	i	k	l	o	p	q	q_1	r	s	t	u	w	h_1
22	250	180	10	22	215	4	237	44	360	50	161	226	199	215	Pg 21	18	24,5	6	58	—
27	250	180	10	22	215	4	237	44	380	50	171	226	209	235	Pg 21	18	24,5	6	58	—
32	250	180	12	28	215	4	237	57	433	60	188	263	245	265	Pg 21	18	31	8	58	—
37	250	180	12	28	215	4	237	57	458	60	200	263	258	280	Pg 21	18	31	8	58	—
42	250	180	12	32	215	4	302	67	505	85	212	328	293	312	Pg 21	18	35,5	10	100	150
47	250	180	12	32	215	4	302	67	535	85	227	328	308	335	Pg 21	18	35,5	10	100	150
52	350	250	15	35	300	4	359	80	570	90	240	389	330	353	Pg 21	18	38,5	10	100	150
55	350	250	15	38	300	4	359	85	615	95	260	389	353	375	Pg 21	18	41,5	10	100	150

Fit of the counter piece H 7 Fit of the shaft stumps k 6

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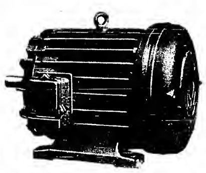
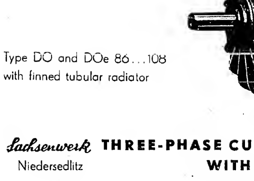
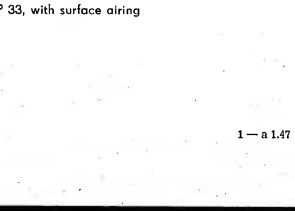


Type DO 65 ... 67 with finned radiator



Type DO and DOe 76 and 77 with finned radiator



Type DO and DOe 86 ... 108 with finned tubular radiator

Sachsenwerk THREE-PHASE CURRENT MOTORS WITH SQUIRREL-CAGE ROTOR

Niedersedlitz

Style of enclosure P 33, with surface airing

Design B 3

Encased three-phase current motors with squirrel-cage rotor

° Style of enclosure: P 33, with surface airing, terminal covering P 43

Anti-friction bearing, design B 3, free shaft stump

Type	Capacity kW	Speed rpm	Nominal current at 380 volts A	Efficiency %	Capacity factor cos φ	Weight about kg	Cwts.
Lost motion speed 1500 rpm, starting torque 1,9-...2,6-fold, starting current 5,8-...6,5-fold							
DO 65–4	10	1450	21	86	0,85	192	3.3.0
DO 66–4	14	1455	29	86,5	0,85	204	4.0.0
DO 67–4	19	1455	39	87	0,85	222	4.2.0
DO 76–4	28	1455	56,5	87,5	0,86	410	8.0.0
DO 77–4	34	1460	68,5	88	0,86	480	9.2.0
DO 86–4	46	1465	92	88,5	0,86	580	11.2.0
DO 87–4	58	1465	114	89	0,87	670	13.0.0
DO 96–4	80	1465	156	89,5	0,87	860	17.0.0
DO 97–4	95	1465	185	90	0,87	1030	20.0.0
DO 106–4	140	1470	270	90,5	0,87	1300	25.2.0
DO 107–4	185	1470	352	91	0,88	1485	29.0.0
DO 108–4	230	1470	435	91,5	0,88	1720	34.0.0

From type DO 96–4 for direct coupling only

Encased three-phase current motors with squirrel-cage rotor

Style of enclosure: P 33, with surface airing, terminal covering P 43

Anti-friction bearing, design B 3, free shaft stump

Type	Capacity kW	Speed rpm	Nominal current at 380 volts A	Efficiency %	Capacity factor cos φ	Weight about kg	Cwts.
Lost motion speed 1000 rpm, starting torque 1,8-...2,4-fold, starting current 5,5-...6,2-fold							
DO 65–6	7	960	15	84,5	0,83	192	3.3.0
DO 66–6	10	960	21,5	85,5	0,83	204	4.0.0
DO 67–6	14	965	29,5	86	0,84	222	4.2.0
DO 76–6	19	965	39,5	87	0,84	410	8.0.0
DO 77–6	24	970	50	87,5	0,85	480	9.2.0
DO 86–6	33	970	68	88	0,85	580	11.2.0
DO 87–6	39	970	80	88,5	0,85	670	13.0.0
DO 96–6	58	975	116	89,5	0,86	860	17.0.0
DO 97–6	70	975	131	90	0,86	1030	20.0.0
DO 106–6	100	980	198	90,5	0,86	1300	25.2.0
DO 107–6	125	980	246	91	0,87	1485	29.0.0
DO 108–6	160	980	310	91,5	0,87	1722	34.0.0

From type DO 107–4 for direct coupling only

Encased three-phase current motors with squirrel-cage rotor

Style of enclosure: P 33, with surface airing, terminal covering P 43

Anti-friction bearing, design B 3, free shaft stump

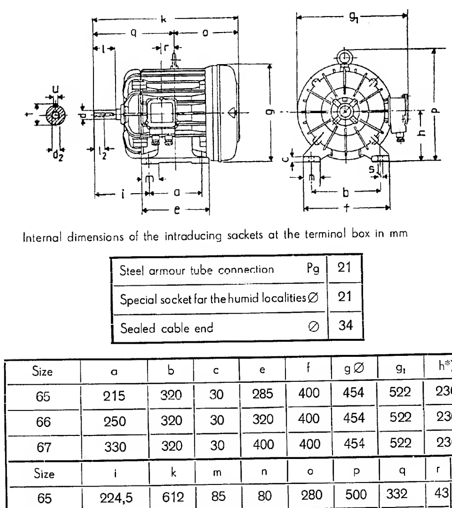
Type	Capacity kW	Speed rpm	Nominal current at 380 volts A	Efficiency %	Capacity factor cos φ	Weight about kg	Weight about Cwts.
Lost motion speed 750 rpm, starting torque 1,7-...2,2-fold, starting current 5-...5,8-fold							
DO 65–8	5	720	12	82,5	0,79	205	4.0.0
DO 66–8	6,5	720	15	83,5	0,80	234	4.3.0
DO 67–8	9,5	725	21,5	84,5	0,80	262	5.1.0
DO 76–8	14	725	31,5	85	0,81	435	8.3.0
DO 77–8	17	725	38	85,5	0,81	505	10.0.0
DO 86–8	25	725	55	86	0,82	615	12.0.0
DO 87–8	30	725	65	87	0,81	710	14.0.0
DO 96–8	42	725	90	88	0,82	920	18.0.0
DO 97–8	54	725	115	88,5	0,82	1100	21.2.0
DO 106–8	80	730	166	89,5	0,83	1300	25.2.0
DO 106–8	100	735	206	90	0,83	1485	29.0.0
DO 108–8	125	735	256	90,5	0,84	1720	34.0.0

Type DOe

Three-phase current motors with increased security against dust-, gas- and steam-mixture, in accordance to the regulations of the VDE 0165, with squirrel-cage rotor, style of enclosure P 33, with surface airing, terminal covering P 44, with cable terminals, from shaft stump.

Anti-friction bearing, design B 3.

For these engines see the technical tables of the types DO, the motor capacity and the current must however be reduced for 5% and pay full attention to the technical explanations in the introduction.



Internal dimensions of the introducing sockets at the terminal box in mm

Steel armour tube connection	Pg	21
Special socket for the humid localities	∅	21
Sealed cable end	∅	34

Size	a	b	c	e	f	g ∅	g_1	h*)
65	215	320	30	285	400	454	522	230
66	250	320	30	320	400	454	522	230
67	330	320	30	400	400	454	522	230

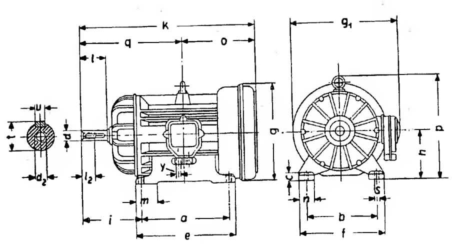
Size	i	k	m	n	o	p	q	r	s∅
65	224,5	612	85	80	280	500	332	43	23
66	254,5	677	85	80	297	500	379,5	60	23
67	254,5	757	85	80	337	500	419,5	100	23

Size	Shaft stump					
	d**)	l	t	u	d_2	l_2
65	38	80	41,5	10	M 12	38
66	45	110	48,5	14	M 16	45
67	45	110	48,5	14	M 16	45

*) Admissible deviation h = minus 0,5 mm (abt. 1/64 inch.)

**) Fit: ISA k 6 according to DIN 7160 sheet 3

Measures in mm



Size	a	b	c	e	f	g	g_1	h*)	i	k	m	n	o	p	q	s	y⌀
76	460	420	40	540	515	550	690	260	325	990	150	95	435	570	555	23	44
77	530	420	40	610	515	550	680	260	325	1060	150	95	470	570	590	23	44
86	500	520	45	580	620	625	775	280	355	1060	160	105	455	635	605	27	44
87	580	520	45	660	620	625	775	280	355	1140	160	105	495	635	645	27	44
96	490	570	55	580	680	710	900	340	425	1185	200	110	515	740	670	27	60
97	560	570	55	650	680	710	900	340	425	1255	200	110	550	740	705	27	60

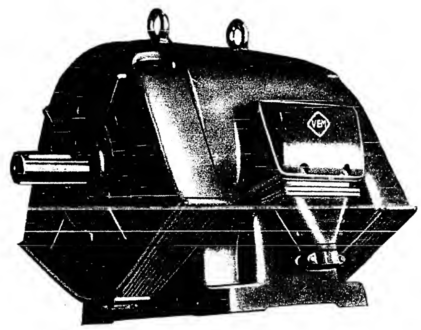
Size	Shaft stump					
	d**)	l	t	u	d_2	l_2
76	55	110	58,5	16	M 20	53
77	55	110	58,5	16	M 20	53
86	65	140	69,2	18	M 20	53
87	65	140	69,2	18	M 20	53
96	75	140	79,6	20	M 20	53
97	75	140	79,6	20	M 20	53

*) Admissible deviation
h = minus 0,5 mm
(abt. $^1/_{64}$ inch.)

**) Fit: ISA k 6 according
to DIN 7160 sheet 3

Measures in mm

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



THREE-PHASE
DOUBLE SQUIRREL-CAGE INDUCTION MOTORS

Design B 3

Protective system P 12

Sanitized Copy Approved for Release 2010/08/18 : CIA-RDP81-01043R000400210006-4

Three-phase double squirrel-cage induction motors

Protective system P 12

Anti-friction bearing, design B 3, free shaft stump

Type	Capacity kW	Capacity HP	Speed about rpm.	Rated current at 380 volts abt. amp.	Efficiency abt. %	Power factor cos φ about	Approx. weight kg	Approx. weight cwts.
No-load speed 3000 rpm.								
KD 60/2	22	30	2860	44	86,5	0,88	170	3.1.11
KD 62/2	25	34	2860	50	87	0,88	185	3.2.11
KD 65/2	30	40	2860	59	87	0,88	220	4.1.9
KD 70/2	35	47,5	2880	68	87,5	0,89	260	5.0.10
KD 72/2	44	60	2880	86	87,5	0,89	295	5.3.6
KD 75/2	55	75	2880	106	88	0,89	335	6.2.11
D 12/2	63	86	2890	121	88,5	0,89	450	8.3.12
D 13/2	80	109	2890	154	88,5	0,89	530	10.1.20
D 14/2	100	136	2900	190	89	0,90	680	13.1.15
D 15/2	125	170	2900	236	89,5	0,90	760	14.3.23
D 16/2	160	218	2920	300	89,5	0,90	835	16.1.11
D 17/2	200	272	2920	375	90	0,90	1030	20.1.3
D 18/2	250	340	2925	466	90,5	0,00	1230	24.0.24
D 19/2	315	428	2925	588	90,5	0,90	1400	27.7.7

Standard voltages of the motors 220, 380 or 500 volts, 50 c. p. s. In case of other voltages and frequencies with you, please write for the corresponding dates.

For easy starting drives, motors with high-rod rotors are recommended.

Starting either directly or with star-delta switch (to be mentioned in order).

Three-phase double squirrel-cage induction motors

Protective system P 12

Anti-friction bearing, design B 3, free shaft stump

Type	Capacity kW	Capacity HP	Speed about rpm.	Rated current at 380 volts abt. amp.	Efficiency abt. %	Power factor cos φ about	Approx. weight kg	Approx. weight cwts.
No-load speed 1500 rpm.								
KD 60/4	15	20	1425	31	86,5	0,85	170	3.1.11
KD 62/4	18,5	25	1430	37,5	87	0,86	185	3.2.15
KD 65/4	22	30	1430	44,5	87	0,86	220	4.1.9
KD 70/4	30	40	1430	60,5	87,5	0,86	260	5.0.13
KD 72/4	37	50	1440	73,5	88	0,87	295	5.3.6
KD 75/4	44	60	1450	87	88,5	0,87	335	6.2.11
D 12/4	50	68	1450	98,5	88,5	0,87	450	8.3.12
D 13/4*)	63	86	1450	122	89	0,88	530	10.1.20
D 14/4*)	80	109	1450	155	89,5	0,88	680	13.1.15
D 15/4*)	100	136	1460	190	90	0,89	760	14.3.23
D 16/4*)	125	170	1460	235	90,5	0,89	835	16.1.21
D 17/4*)	160	218	1460	302	90,5	0,89	1030	20.1.3
D 18/4*)	200	272	1460	374	91	0,89	1230	24.0.24
D 19/4*)	250	340	1460	468	91	0,69	1400	27.2.7

Standard voltages of the motors 220, 380 or 500 volts, 50 c. p. s. In case of other voltages and frequencies with you, please write for the corresponding dates.

For easy starting drives, motors with high-rod rotors are recommended.

Starting either directly or with star-delta switch (to be mentioned in order).

*) With base plate and external bearing according to design C 2, available at extra charge.

Three-phase double squirrel-cage induction motors

Pratective system P 12

Anti-frictian bearing, design B 3, free shaft stump

Type	Capacity kW	Capacity HP	Speed about rpm.	Rated current at 380 volts abt. amp.	Effi-ciency abt. %	Power factor cos φ about	Approx. weight kg	Approx. weight cwts.
No-load speed 1000 rpm.								
KD 60/6	9,2	12,5	940	19,8	85	0,83	170	3.1.11
KD 62/6	11	15	940	23,4	85	0,84	165	3.2.15
KD 65/6	16	22	940	33,2	86	0,85	220	4.1.9
KD 70/6	18,5	25	940	38	87	0,85	260	5.0.13
KD 72/6	22	30	950	45	87	0,85	295	5.3.6
KD 75/6	30	40	950	61	87,5	0,85	335	6.2.11
D 12/6	38	52	950	76	88	0,86	450	8.3.12
D 13/6*)	50	68	950	100	88,5	0,86	530	10.1.20
D 14/6*)	63	86	960	124	89	0,87	680	13.1.15
D 15/6*)	80	109	960	156	89,5	0,87	760	14.3.23
D 16/6*)	100	136	960	192	90	0,88	835	16.1.21
D 17/6*)	125	170	960	238	90,5	0,88	1030	20.1.3
D 18 6*)	160	218	965	305	90,5	0,83	1230	24.0.24
D 19/6*)	200	272	965	380	91	0,88	1400	27.2.7

Standard voltages of the motors 220, 380 or 500 valts, 50 c. p. s. In case af other valtages and frequencies with you, please write far the corresponding dates.

For easy starting drives, motors with high-rad ratars are recammended.

Starting either directly ar with star-delta switch (ta be mentioned in order).

*) With base plate and external bearing accarding ta design C 2, available at extra charge.

Three-phase double squirrel-cage induction motors

Protective system P 12

Anti-friction bearing, design B 3, free shaft stump

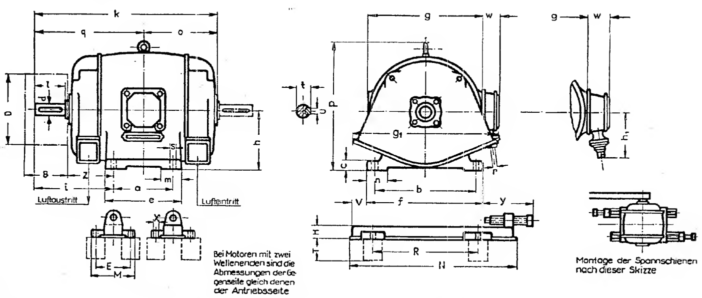
Type	Capacity kW	Capacity HP	Speed about rpm.	Rated current at 380 volts abt. amp.	Effi-ciency abt. %	Power factor cos. φ about	Approx. weight kg	Approx. weight cwts.
No-load speed 750 rpm.								
KD 60/8	7	9,5	705	16,6	82	0,78	170	3.1.11
KD 62/8	8	11	705	18,8	83	0,78	185	3.2.15
KD 65/8	10	13,6	710	23	83,5	0,79	220	4.1.9
KD 70/8	12	16,3	710	27,6	83,5	0,79	260	5.0.13
KD 72,8	16	22	710	36	84,5	0,80	295	5.3.6
KD 75/8	22	30	710	48	86	0,81	335	6.2.11
D 12/8*)	28	38	715	60	86,5	0,82	450	8.3.12
D 13/8*)	38	52	715	81	87	0,82	530	10.1.20
D 14/8*)	50	68	720	104	87,5	0,83	680	13.1.15
D 15/8*)	63	86	720	131	88	0,83	760	14.3.23
D 16,8*)	80	109	720	166	88	0,83	835	16.1.21
D 17/8*)	100	136	720	205	88	0,84	1030	20.1.3
D 18/8*)	125	170	725	255	88,5	0.84	1230	24.0.24
D 19/8*)	160	218	725	327	88,5	0,84	1400	27.2.7

Motors for 600 and 500 rpm. upon request.

Standard voltages of the motors 220, 380 or 500 volts, 50 c. p. s. In case of other voltages and frequencies with you, please write for the corresponding dates.

For easy starting drives, motors with high-rod rotors are recommended.
Starting either directly or with star-delta switch (to be mentioned in order).

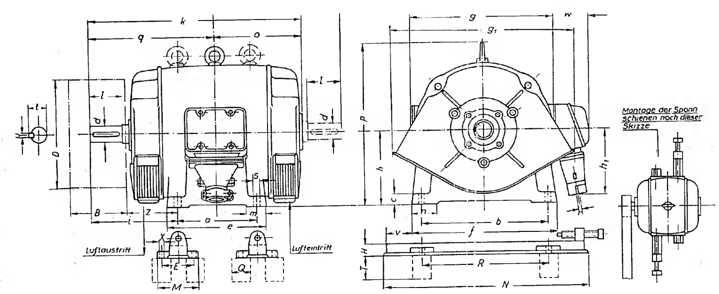
*) With base plate and external bearing according to design C 2, available at extra charge.



Luftaustritt = Air outlet Lufteintritt = Air inlet Bei Motoren mit . . . = For motors with two shaft ends the dimensions of the counter side are equal to those of the drive side
Montage der Spannschienen . . . = Mounting of the tension rails following this draft

																								Pulley			Tension rails									
Type	a	b	c	d	e	f	g	g_1	h	h_1	i	k	l	m	n	o	p	q	r	s	t	u	w	B	D	Z	E	H	M	N	Q	R	T	V	X	Y
60	180	380	35	42	250	440	420	540	235	175	302	635	105	70	80	243	495	392	Pg 29	25	46	12	115	140	250	182	120	55	180	700	80	400	400	160	M20	200
62	205	380	35	42	275	440	420	540	235	175	302	660	105	70	80	255	495	405	Pg 29	25	46	12	115	170	320	182	120	55	180	700	80	400	400	160	M20	200
65	240	380	35	45	310	440	420	540	235	175	288	698	110	70	80	290	495	408	Pg 29	25	49	14	115	170	320	163	120	55	180	700	80	400	400	160	M20	200
70	210	440	40	55	290	520	480	610	280	175	310	700	110	90	100	285	595	415	Pg 36	25	59	16	115	200	320	185	150	72	200	825	80	490	400	180	M20	200
72	245	440	40	55	325	520	480	610	280	175	310	735	110	90	100	302	595	433	Pg 35	25	59	16	115	300	360	185	150	72	200	825	80	490	400	180	M20	200
95	320	440	40	65	400	520	480	610	280	175	340	840	140	90	100	340	595	500	Pg 36	25	70	18	115	230	400	185	150	72	200	825	80	490	400	180	M20	200

Fit of the counter piece: H 7 – Fit of the shaft stumps: up to a diameter of 45 mm (abt. 1¾") k 6 – more than 45 Ø m 6



Luftaustritt = Air outlet Lufteintritt = Air inlet

Montage der . . . = Mounting of the tension rails following this draft

																								Pulley			Tension rails								
Type	o	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	w	h_1	g_1	B	D	Z	E	H	M	N	Q	R	T	V	X
12	255	500	50	65	355	600	570	335	375	823	140	100	105	320	710	502,5	50	30	69	18	135	300	710	230	400	205	160	80	240	1000	80	590	500	200	M 30
13	310	500	50	65	410	600	570	335	375	878	140	100	105	348	710	530	50	30	69	18	135	300	710	230	450	205	160	80	240	1000	80	590	500	200	M 30
14	300	600	60	75	400	700	665	375	424	962	140	100	140	388	805	574	50	30	79,4	20	135	300	830	260	450	254	180	90	260	1170	80	650	500	200	M 24
15	380	600	60	75	480	700	665	375	424	1042	140	100	140	428	805	614	50	30	79,4	20	135	300	830	260	500	254	180	90	260	1170	80	650	500	200	M 24
16	360	670	60	80	465	770	740	400	460	1064	170	110	135	424	870	640	80	36	85,3	22	170	350	920												
17	425	670	60	85	530	770	740	400	460	1129	170	110	135	456	870	672	80	36	90,3	22	170	350	920												
18	410	740	70	90	530	860	810	450	475	1132	170	120	160	452	955	680	80	42	95,1	25	170	350	1000												
19	490	740	70	95	600	860	810	450	475	1212	170	120	160	492	955	720	80	42	100,1	25	170	350	1000												

Fit of the counter piece: H 7 – Fits of the shaft stumps: m 6

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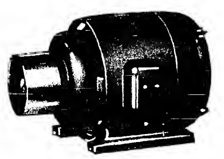
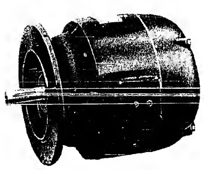
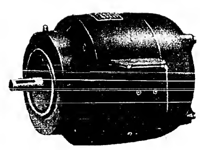
Design B 3





Design B 5

Design B 14



VEM THREE-PHASE CURRENT MOTORS WITH SQUIRREL-CAGE ROTOR

Style of enclosure: P 33

Design B 3, B 5, B 14

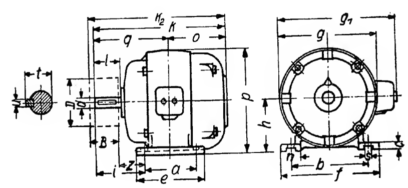
Sanitized Copy Approved for Release 2010/08/18 : CIA-RDP81-01043R000400210006-4

Three-phase current motors with squirrel-cage rotor

Style of enclosure: P 33, with surface cooling
Anti-friction bearing: design B 3, B 5, B 14, free shaft stump

Type	Nominal capacity kW	Nominal capacity HP	Nominal speed rpm	Current at 380 volts A	Efficiency n	Capacity factor cos φ	Weight about kg	Weight about lbs.
Speed 3000 rpm								
DH 012	0,125	0,17	2800	0,42	0,65	0,67	6	13
DH 022	0,2	0,27	2800	0,57	0,68	0,78	6	13
DH 112	0,33	0,45	2803	0,9	0,69	0,81	8	18
DH 122	0,5	0,7	2800	1,3	0,71	0,84	11	24
DH 312	0,8	1,1	2830	1,95	0,74	0,84	16	35
DH 322	1,1	1,5	2840	2,63	0,75	0,85	20	44
DH 332	1,5	2	2850	3,45	0,77	0,86	25	56
DH 342	2,2	3	2855	4,9	0,79	0,87	34	75
Speed 1500 rpm								
DH 114	0,2	0,27	1400	0,61	0,67	0,75	8	18
DH 124	0,33	0,48	1400	0,95	0,69	0,76	11	24
DH 314	0,5	0,7	1410	1,3	0,72	0,81	16	35
DH 324	0,8	1,1	1420	1,95	0,76	0,82	20	44
DH 334	1,1	1,5	1425	2,6	0,78	0,83	25	56
DH 344	1,5	2	1430	3,5	0,78	0,83	34	75
Speed 1000 rpm								
DH 116	0,125	0,17	890	0,48	0,61	0,64	8	18
DH 126	0,2	0,27	900	0,76	0,62	0,65	11	24
DH 316	0,33	0,45	915	0,95	0,71	0,75	16	35
DH 326	0,5	0,7	920	1,4	0,73	0,76	20	44
DH 336	0,8	1,1	925	2,15	0,74	0,77	25	56
DH 346	1,1	1,5	925	2,9	0,74	0,77	34	75
Speed 750 rpm								
DM 318	0,2	0,27	700	0,73	0,7	0,60	16	35
DM 328	0,33	0,45	705	1,1	0,71	0,64	20	44
DM 338	0,5	0,7	710	1,57	0,72	0,67	25	56
DM 348	0,8	1,1	710	2,5	0,72	0,68	34	75

These motors are encased engines with surface-cooling, and in consequence of their construction and style of enclosure (P 33) according to DIN 40 050 they are specially suitable for dusty and rough factories such as for tool machines, the woodworking industry, textile industry, pumps, and for agricultural purposes.



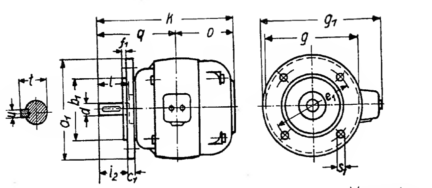
Design B 3 — Measures in mm

Model	a	b	c	d	e	f	g	g_1	h	i	k	k_2
01/02	70	100	10	10	86	116	122	160	63	65	185	—
11	70	126	12	14	94	150	156	202	80	75	204	216
12	90	126	12	14	114	150	156	202	80	75	220	233
31	90	168	16	18	122	200	205	246	105	99	258	268
32	110	168	16	18	142	200	205	246	105	99	278	288
33	140	168	16	20	172	200	205	246	105	99	308	318
34	180	168	16	20	212	200	205	246	105	99	348	358

Design B 3 — Measures in mm

Model*)	l	n	o	p	q	s	t	u	z	D	B
01,02	37	16	85	124	100	7	—	—	—	—	—
11	36	24	94	158	110	10	16,1	5	39	50	50
12	36	24	101	158	120	10	16,1	5	39	63	50
31	50	32	114	207	144	14	20,5	6	49	63	60
32	50	32	124	207	154	14	20,5	6	49	80	60
33	55	32	139	207	169	14	22,5	6	49	100	60
34	55	32	159	207	189	14	22,5	6	49	125	85

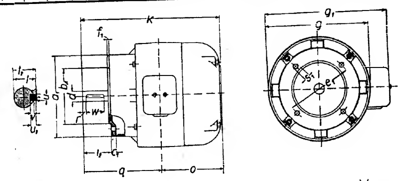
*) The third number of the model indication represents the pole-number. It is without any influence on the dimensions and therefore not noted.



Design B 5

Measure in mm

Madel*)	a_1	b_1	c_1	d	e_1	f_1	g	g_1	i_2	k	l	o	q	s_1	t	u
01/02	120	80	6	10	100	2	122	159	36	185	—	85	100	7	—	—
11	165	110	10	14	140	3	156	202	41	204	36	94	110	7	17,1	5
12	165	110	10	14	140	3	156	202	41	221	36	100	120	7	17,1	5
31	200	130	10	18	165	3,5	205	246	46	258	50	114	144	11,5	20,5	6
32	200	130	10	18	165	3,5	205	246	46	278	50	124	154	11.5	20,5	6
33	200	130	10	20	165	3,5	205	246	46	308	55	139	169	11,5	22,5	6
34	200	130	10	20	165	3,5	205	246	46	348	55	159	189	11,5	22,5	6



Design B 14

Measures in mm

Model*)	a_1	b_1	c_1	d	e_1	f_1	g	g_1	i_2	k	a	q	r	s_1	t	t_2	u	u_2	v	w
01/02	90	60	8	10	75	3	122	159	37	185	85	100	—	M 5	—	—	—	—	—	—
11	120	80	10	14	100	3	156	194	41	200	94	110	5	M 6	16,1	17,3	5	5	2,9	25
12	120	80	10	14	100	3	156	194	41	220	101	120	5	M 6	16,1	17,3	5	5	2,9	25
31	162	110	10	18	130	3,5	205	243	55	259	115	144	7,5	M 8	20,5	22,7	6	6	3,5	36
32	162	110	10	18	130	3,5	205	243	55	279	125	154	7,5	M 8	20,5	22,7	6	6	3,5	36
33	162	110	10	20	130	3,5	205	243	55	309	140	169	7,5	M 8	22,5	22,7	6	6	3,5	36
34	162	110	10	20	130	3,5	205	243	55	349	160	189	7,5	M 8	22,5	22,7	6	6	3,5	36

*) The third number of the madel indication represents the pale-number. It is without any influence on the dimensians and therefore not nated

THREE-PHASE MOTORS

Design B 3 Protective system P 33 380 and 500 volts

with slip ring rotor, type DSU

(with and without brush lifting device)

with double squirrel-cage rotor, type DKU

with high-rod rotor, type DHU

Type	Capacity in kW at			
	3000 rpm.	1500 rpm.	1000 rpm.	750 rpm.
731	230	180	125	
733	280	230	140	125
735	360	280	180	140
841	450	360	230	180
843	540	430	260	210
845		520	315	260
981			390	310
983			460	390
985				460

The totally-enclosed motors, protective system P 33, are fitted with a pipe system situated under the motor jacket. The heated air is ventilated by a fan within the interior of the motor and is distributed into the pipe system. There it is cooled by a counter current of air which an outward fan placed on the motor shaft produces.

The motors are going to be designed. Further dates on request.

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THREE-PHASE H.T. MOTORS

Design B 3 Protective system P 33 2000 and 3000 volts

with slip ring rotor, type DSU
(with and without brush lifting device)

with double squirrel-cage rotor, type DKU

with high-rod rotor, type DHU

Type	Capacity in kW at			
	3000 rpm.	1500 rpm.	1000 rpm.	750 rpm.
731	200	160		
733	250	200	125	
735	320	250	160	125
841	380	320	200	160
843	450	380	230	200
845	580	450	280	230
981	660	550	350	280
983	800	660	400	350
985	950	800	480	400

The totally-enclosed motors, protective system P 33, are fitted with a pipe system situated under the motor jacket. The heated air is ventilated by a fan within the interior of the motor and is distributed into the pipe system. There it is cooled by a counter current of air which an outward fan placed on the motor shaft produces.

The motors are going to be designed. Further dates on request.

Sanitized Copy Approved for Release 2010/08/18 : CIA-RDP81-01043R000400210006-4

THREE-PHASE H.T. MOTORS

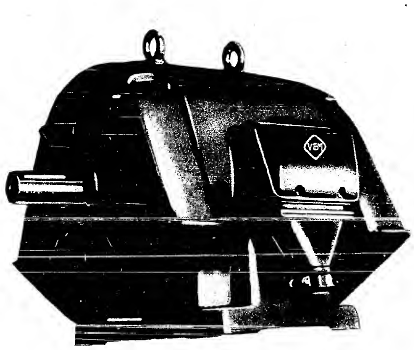
Design B 3 Protective system P 33 5000 and 6000 volts

with slip ring rotor, type DSU
(with and without brush lifting device)
with double squirrel-cage rotor, type DKU
with high-rod rotor, type DHU

Type	Capacity in kW at			
	3000 rpm.	1500 rpm.	1000 rpm.	750 rpm.
731	160	125		
733	200	160		
735	250	200	125	
841	320	250	160	125
843	380	300	200	160
845	450	380	230	200
981	550	450	260	230
983	660	550	320	280
985	800	630	400	320

The totally-enclosed motors, protective system P 33, are fitted with a pipe system situated under the motor jacket. The heated air is ventilated by a fan within the interior of the motor and is distributed into the pipe system. There it is cooled by a counter current of air which an outward fan placed on the motor shaft produces.

The motors are going to be designed. Further dates on request.



THREE-PHASE
HIGH-ROD MOTORS WITH SQUIRREL-CAGE ROTOR

Design B 3

Protective system P 12

Three-phase high-rod motors with squirrel-cage rotor

Protective system P 12

Anti-friction bearing, design B 3, free shaft stump

Type	Capacity kW	Capacity HP	Speed about rpm.	Roted current ot 380 volts abt. omp	Effi-ciency obt. %	Power foctor cos φ about	Approx. weight kg	Approx. weight cwts.
No-lood speed 3000 rpm.								
H 12/2	63	86	2890	121	88,5	0,89	450	8.3.12
H 13/2	80	109	2890	154	88,5	0,89	530	10.1.20
H 14/2	100	136	2900	190	89	0,90	680	13.1.15
H 15/2	125	190	2900	236	89,5	0,90	760	14.3.23
H 16/2	160	218	2920	300	89,5	0,90	835	16.1.21
H 17/2	200	272	2920	375	90	0,90	1030	20.0.11
H 18/2	250	340	2925	466	90,5	0,90	1230	24.0.24
H 19/2	315	428	2925	588	90,5	0,90	1400	27.2.10
No-lood speed 1500 rpm.								
H 12/4	50	68	1440	98,5	88,5	0,87	450	8.3.12
H 13/4	63	86	1450	122	89	0,88	530	10.1.20
H 14/4	80	109	1450	155	89,5	0,88	680	13.1.15
H 15/4	100	136	1460	190	90	0,89	760	14.3.23
H 16/4*)	125	170	1460	235	90,5	0,89	835	16.1.21
H 17/4*)	160	218	1460	302	90,5	0,89	1030	20.0.11
H 18/4*)	200	272	1460	374	91	0,89	1230	24.0.24
H 19/4*)	250	340	1460	468	91	0,89	1400	27.2.10

*) **Design C 2 available at extra charge.**

Standard voltages of the motors 220, 380 or 500 volts, 50 c. p. s. In case of other voltages and frequencies with you, please write for the corresponding dates.

Standard design for direct switching.

Three-phase high-rod motors with squirrel-cage rotor

Protective system P 12

Anti-friction bearing, design B 3, free shaft stump

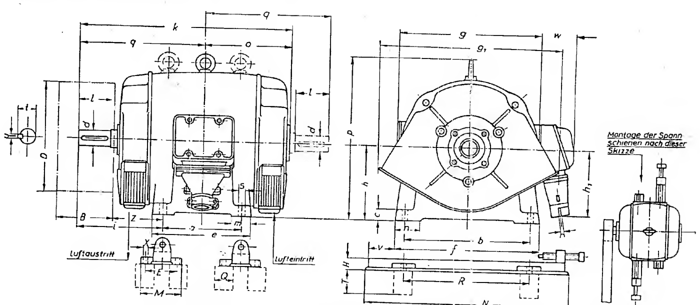
Type	Capacity kW	Capacity HP	Speed obout rpm.	Rated current ot 380 volts obt. amp.	Effi-ciency abt. %	Power foctor cos φ about	Approx. weight kg	Approx. weight cwts.
No-lood speed 1000 rpm.								
H 12/6	38	52	950	76	88	0,86	450	8.3.12
H 13/6	50	68	950	100	88,5	0,86	530	10.1.20
H 14/6	63	86	960	124	89	0,87	680	13.1.15
H 15/6	80	109	960	156	89,5	0,87	760	14.3.23
H 16/6*)	100	136	960	192	90	0,88	835	16.1.21
H 17/6*)	125	170	960	238	90,5	0,88	1030	20.0.11
H 18/6*)	160	218	965	305	90,5	0,88	1230	24.0.24
H 19/6*)	200	272	970	380	91	0,88	1400	27.2.10
No-lood speed 750 rpm.								
H 12/8	28	38	715	60	86,5	0,82	450	8.3.12
H 13/8	38	52	715	81	87	0,82	530	10.1.20
H 14/8	50	68	720	104	87,5	0,83	680	13.1.15
H 15/8	63	86	720	131	88	0,83	760	14.3.23
H 16/8*)	80	109	720	166	88	0,83	835	16.1.21
H 17/8*)	100	136	725	205	88	0,84	1030	20.0.11
H 18/8*)	125	170	725	255	88,5	0,84	1230	24.0 24
H 19/8*)	160	218	725	327	88,5	0,84	1400	27.2.10

*) Design C 2 available at extra charge.

Motors for 600 and 500 rpm. upon request.

Standard voltages of the motors 220, 380 or 500 volts, 50 c. p. s. In case of other voltages and frequencies with you, please write for the corresponding dates.

Standard design for direct switching.

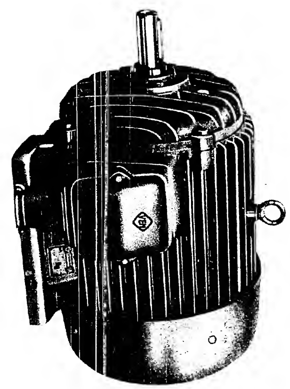


Luftaustritt = Air outlet Lufteintritt = Air inlet Montage der Spannschienen .. = Mounting of the tension rails following this draft
Riemenscheibe = Pulley Spannschienen = Tension rails

Typ	o	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	w	h_1	g_1	Riemenscheibe			Spannschienen								
																								B	D	Z	E	H	M	N	Q	R	T	V	X
12	255	500	50	65	355	600	570	335	375	823	140	100	105	320	710	502,5	50	30	69	18	135	300	710	230	400	205	160	80	240	1000	80	590	500	200	M 24
13	310	500	50	65	410	600	570	335	375	878	140	100	105	348	710	530	50	30	69	18	135	300	710	230	450	205	160	80	240	1000	80	590	500	200	M 24
14	300	600	60	75	400	700	665	375	424	962	140	100	140	388	805	574	50	30	79,4	20	135	300	830	260	450	254	180	90	260	1170	80	650	500	200	M 30
15	380	600	60	75	480	700	665	375	424	1042	140	100	140	428	805	614	50	30	79,4	20	135	300	830	260	500	254	180	90	260	1170	80	650	500	200	M 30
16	360	670	60	80	465	770	740	400	460	1064	170	110	135	424	870	640	80	36	85,3	22	170	350	920												
17	425	670	60	85	530	770	740	400	460	1129	170	110	135	456	870	672	80	36	90,3	22	170	350	920												
18	410	740	70	90	520	860	810	450	475	1132	170	120	160	452	955	680	80	42	95,1	25	170	350	1000												
19	490	740	70	95	600	860	810	450	475	1212	170	120	160	492	955	720	80	42	100,1	25	170	350	1000												

Fit of the counter piece: H 7 — Fits of the shaft stumps: m 6 — Dimensions without engagement

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



THREE-PHASE MOTORS
WITH SQUIRREL-CAGE ROTOR

Design B 3

Protective system P 33

Three-phase motors with squirrel-cage rotor

Protective system P 33, with surface-cooling by finned radiator

Anti-friction bearing, design B 3, free shaft stump

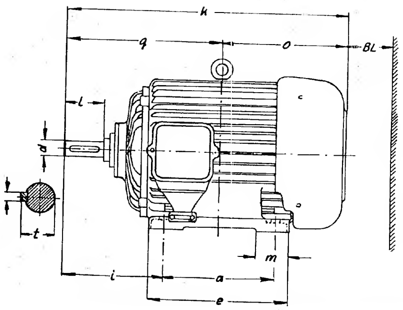
Type	Capacity		Rated speed	Rated current at 380 volts	Effi-ciency	Power factor	Approx. weight	
	kW	HP	rpm.	amp.	%	cos φ	kg	cwts.
No-load speed 3000 rpm.								
AKR 322/2	20	27,2	2930	38,7	87	0,9	245	4.3.8
AKR 325/2	28	38,08	2940	54	87	0,9	285	5.2.12
AKR 412/2	38	51,68	2950	73	88	0,9	410	8.0.8
AKR 416/2	50	68	2950	96	88	0,9	475	9.1.11
AKR 492/2	63	85,58					680	13.1.15
AKR 496/2	80	108,8					780	15.1.12
AKR 572/2	100	136					1020	20.0.11
AKR 576/2	125	170					1150	22.2.15
AKR 652/2	160	211,6					1380	27.0.0
AKR 656/2	200	272					1550	30.0.0
AKR 732/2	250	340					2050	40.0.0
AKR 736/2							2250	44.0.0
No-load speed 1500 rpm.								
AKR 322/4	14	19,04	1460	27,3	89	0,88	245	4.3.8
AKR 325/4	20	27,2	1465	39	89	0,88	285	5.2.12
AKR 412/4	28	38,08	1475	52	91	0,89	410	8.0.8
AKR 416/4	38	51,68	1475	71	91	0,89	475	9.1.11
AKR 492/4	50	68	1490	92	92	0,89	680	13.1.15
AKR 496/4	63	85,16	1480	116	92	0,89	780	15.1.12
AKR 572/4	80	108,8	1480	146	92,5	0,9	1020	20.0.11
AKR 576/4	100	136	1480	180	93	0,9	1150	22.2.15
AKR 652/4	125	170	1485	224	93,5	0,9	1380	27.0.0
AKR 656/4	160	217	1485	288	93	0,9	1550	30.0.0
AKR 732/4	200	272	1480	360	92,5	0,91	2050	40.0.0
AKR 736/4	250	340	1485	433	92	0,91	2250	44.0.0

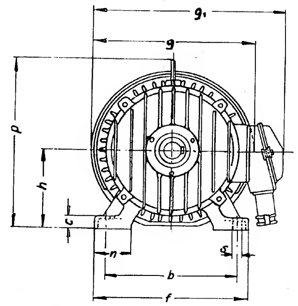
Three-phase motors with squirrel-cage rotor

Protective system P 33, with surface-cooling by finned radiator

Anti-friction bearing, design B 3, free shaft stump

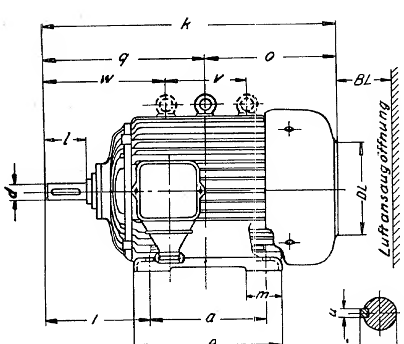
Type	Capacity		Rated speed	Rated current at 380 volts	Effi-ciency	Power factor	Approx. weight	
	kW	HP	rpm.	amp.	%	cos φ	kg	cwts.
No-load speed 1000 rpm.								
AKR 322/6	10	13,6	965	20,5	87	0,85	245	4.3.8
AKR 325/6	14	19,04	965	28	88	0,86	285	5.2.12
AKR 412/6	20	27,2	980	39	88	0,88	410	8.0.8
AKR 416/6	28	38,08	980	53,5	90	0,87	475	9.1.11
AKR 492/6	38	51,68	985	73	90,5	0,87	680	13.1.15
AKR 496/6	50	68	985	95	90,5	0,87	780	15.1.12
AKR 572/6	63	85,68	985	118	91	0,89	1020	20.0.11
AKR 576/6	80	108,8	985	149	91,5	0,89	1150	22.2.15
AKR 652/6	100	136	985	190	91	0,88	1380	27.0.0
AKR 656/6	125	170	985	232	92	0,89	1550	30.0.0
AKR 732/6	160	218	985	286	93	0,91	2050	40.0.0
AKR 736/6	200	272	990	354	93,5	0,92	2250	44.0.0
No-load speed 750 rpm.								
AKR 322/8	7	9,52	710	16,5	85	0,76	245	4.3.8
AKR 325/8	10	13,6	730	21,3	86	0,84	285	5.2.12
AKR 412/8	14	19,04	735	28,5	87	0,85	410	8.0.8
AKR 416/8	20	27,2	738	40,5	87,5		475	9.1.11
AKR 492/8	28	38,08	738	57,5	84	0,83	680	13.1.15
AKR 496/8	38	51,68	718	98	90	0,83	780	15.1.12
AKR 572/8	50	68	740	97	89,5	0,87	1020	20.0.13
AKR 576/8	63	85,68	740	120	90	0,88	1150	22,2.15
AKR 652/8	80	108,8					1380	27.0.0
AKR 656/8	100	136					1550	30.0.0
AKR 732/8	125	170					2050	40.0.0
AKR 736/8	160	211,6					2250	44.0.0

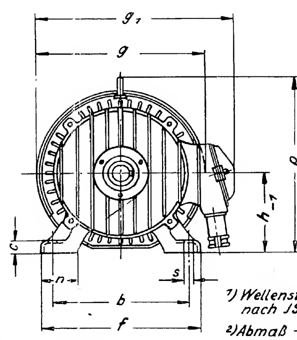




Type	a	b	c	d	e	f	g	g¹	h	i	k	l	m	n	o	p	q	s	t	u	BL
AKR 322	320	370	35	45	400	440	460	544	225	276	803	110	95	100	367	500	536	23	48,5	14	50
AKR 325	320	370	35	45	400	440	460	544	225	276	803	110	95	100	367	500	436	23	48,5	14	50
AKR 412	325	460	45	55	415	540	555	671	280	300	868	110	110	125	405,5	613	462,5	23	58,8	16	60
AKR 416	390	460	45	55	480	540	555	671	280	300	933	110	110	125	438	613	495	23	58,8	16	60
AKR 492	400	545	55	65	500	640	670	797	335	355	1037	140	125	150	482	737	555	27	69,2	18	65
AKR 496	460	545	55	65	560	640	670	797	335	355	1097	140	125	150	512	737	585	27	69,2	18	65

Dimensions in mm without engagement





1) Wellenstumpf nach JSA m6

2) Abmaß -1

Luftansaugöffnung = Suction air hole

Wellenstumpf nach JSA m 6 = Shaft stump according to JSA m 6

Abmaß – 1 = Gauge - 1

Type	a	b	c	d¹)	e	f	g	g_1	h¹)	i	k	l	m	n	o	p	q	s	t	u	BL/min	DL
AKR 572	460	630	60	75	580	740	765	890	375	385	1168	140	140	175	553	844	615	33	79,6	20	70	390
AKR 576	520	630	60	75	640	740	765	890	375	385	1228	140	140	175	583	844	645	33	79,6	20	70	390
AKR 652	530	720	70	85	660	840	870	997	425	440	1326	170	155	200	621	970	705	33	90,5	22		
AKR 656	590	720	70	85	720	840	870	997	425	440	1386	170	155	200	651	970	735	33	90,5	22		445
AKR 732	550	810	80	90	690	950	972	1083	475	460	1405	170	170	225	670	1071	735	39	95,3	25		500
AKR 736	660	810	80	95	800	950	920	1083	475	460	1515	170	170	225	725	1071	790	39	100,3	25		500

Dimensions in mm without engagement

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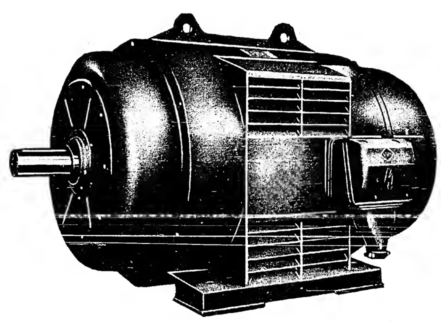
DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



THREE-PHASE H.T. MOTORS WITH HIGH-ROD OR DOUBLE SQUIRREL-CAGE ROTORS

Design B 3

Protective system P 12

2000 and 3000 volts

Three-phase H. T. motors for 2000 and 3000 volts

Protective system P 12

Anti-friction bearing, design B 3, free shaft stump

With high-rod rotor type	With double squirrel-cage rotor type	Capacity kW	Capacity obt. HP	Roted speed rpm.	Approx. weight kg	Approx. weight cwts.
No load speed 1500 rpm.						
DHE 653/4	DKE 653/4	230	310	1470	1590	31
DHE 655/4	DKE 655/4	275	370	1470	1780	35
DHE 731/4	DKE 731/4	330	450	1470	1970	39
DHE 733/4	DKE 733/4	400	540	1470	2200	43
DHE 735/4	DKE 735/4	475	650	1470	2430	48
DHE 841/4	DKE 841/4	570	775	1475	2760	54
DHE 843/4	DKE 843/4	680	925	1475	3050	60
DHE 845/4	DKE 845/4	820	1115	1475	3570	70
DHE 981/4	DKE 981/4	985	1340	1475	3850	76
DHE 983/4	DKE 983/4	1180	1600	1475	4260	84
DHE 985/4	DKE 985/4	1420	1930	1475	5060	99
No lood speed 1000 rpm.						
DHE 653/6	DKE 653/6	170	230	985	1590	31
DHE 656/6	DKE 655/6	200	270	985	1780	35
DHE 731/6	DKE 731/6	240	325	985	1970	39
DHE 733/6	DKE 733/6	290	395	985	2200	43
DHE 735/6	DKE 735/6	350	475	985	2430	48
DHE 841/6	DKE 841/6	430	580	985	2760	54
DHE 843/6	DKE 843/6	520	710	985	3050	60
DHE 845/6	DKE 845/6	620	840	985	3570	70
DHE 981/6	DKE 981/6	750	1020	985	3850	76
DHE 983/6	DKE 983/6	900	1220	985	4260	84
DHE 985/6	DKE 985/6	1070	1450	985	5060	99

Principle diagrams on request.

Three-phase H. T. motors for 2000 and 3000 volts

Protective system P 12

Anti-friction bearing, design B 3, free shaft stump

With high-rod rotor type	With double squirrel-cage rotor type	Capacity kW	Capacity obt. HP	Roted speed rpm.	Approx. weight kg	Approx. weight cwts.
No lood speed 750 rpm.						
DHE 653/8	DKE 653/8	125	170	730	1590	31
DHE 655/8	DKE 655/8	160	220	730	1780	35
DHE 731/8	DKE 732 8	190	260	730	1970	39
DHE 733/8	DKE 733/8	220	300	730	2200	43
DHE 735/8	DKE 735/8	260	350	730	2430	48
DHE 841/8	DSE 841/8	320	435	735	2760	54
DHE 843/8	DKE 843/8	390	530	735	3050	60
DHE 845/8	DKE 845/8	460	625	735	3570	70
DHE 981/8	DKE 981/8	550	750	735	3850	76
DHE 983/8	DKE 983/8	670	910	735	4260	84
DHE 985/8	DKE 985/8	800	1190	735	5060	99
No lood speed 600 rpm.						
DHE 731/10	DKE 731/10	140	190	560	1970	39
DHE 733/10	DKE 733/10	170	230	560	2200	43
DHE 735/10	DKE 735/10	200	270	560	2430	48
DHE 841/10	DKE 841/10	240	325	560	2760	54
DHE 843/10	DKE 843/10	290	395	560	3050	60
DHE 845/10	DKE 845/10	350	475	560	3570	70

Principle diagrams on request.

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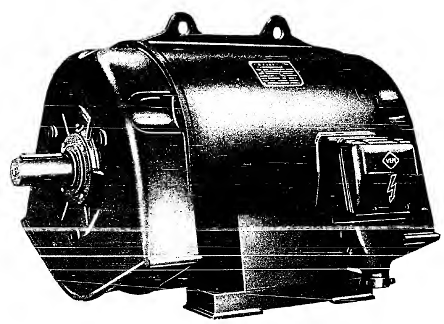
Three-phase H. T. motors for 2000 and 3000 volts

Protective system P 12

Anti-friction bearing, design B 3, free shaft stump

With high-rod rotor type	With double squirrel-cage rotor type	Capacity kW	Capacity abt. HP	Rated speed rpm.	Approx. weight kg	Approx. weight cwts.
No load speed 500 rpm.						
DHE 733/12	DKE 733/12	125	170	450	2200	43
DHE 735/12	DKE 735/12	150	200	450	2430	48
DHE 841/12	DKE 841/12	175	240	450	2760	54
DHE 843/12	DKE 843/12	210	285	450	3050	60
DHE 845/12	DKE 845/12	270	370	450	3570	70

Principle diagrams on request.



THREE-PHASE MOTORS WITH HIGH-ROD OR DOUBLE SQUIRREL-CAGE ROTORS

Design B 3

Protective system P 12

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Three-phase motors with high-rod or double squirrel-cage rotors

Protective system P 12 380/500 volts

Anti-friction bearing, design B 3, free shaft stump

With high-rod rotor type	With double squirrel-coge rotor type	Capacity kW	obt. HP	Roted speed rpm.	Approx. weight kg	cwts.
No-lood speed 1500 rpm.						
DHE 653–4	DKE 653–4	290	395	1470	1590	31
,, 655–4	,, 655–4	350	475	1470	1780	35
,, 731–4	,, 731–4	420	510	1475	1970	39
No-lood speed 1000 rpm.						
DHE 653–6	DKE 653–6	210	285	980	1590	31
,, 655–6	,, 655–6	250	340	980	1780	35
,, 731–6	,, 731–6	310	420	985	1970	39
,, 733–6	,, 733–6	370	500	985	2200	43
,, 735–6	,, 735–6	450	610	985	2430	48
No-lood speed 750 rpm.						
DHE 653–8	DKE 653–8	160	225	735	1590	31
,, 655–8	,, 655–8	200	210	735	1780	35
,, 731–8	,, 731–8	240	325	735	1970	39
,, 733–8	,, 733–8	280	380	735	2200	43
,, 735–8	,, 735–8	340	460	735	2430	48
,, 841–8	,, 841–8	380	515	735	2760	54

Principle diagrams on request.

Three-phase motors with high-rod or double squirrel-cage rotors

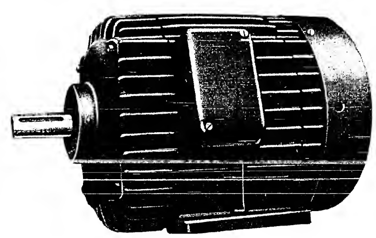
Protective system P 12 380/500 volts

Anti-friction bearing, design B 3, free shaft stump

With high-rod rotor type	With double squirrel-coge rotor type	Capacity kW	obt. HP	Roted speed rpm.	Approx. weight kg	cwts.
No-lood speed 600 rpm.						
DHE 653–10	DKE 653–10	120	165	570	1590	31
,, 655–10	,, 655–10	145	195	570	1780	35
,, 731–10	,, 731–10	175	240	575	1970	39
,, 733–10	,, 733–10	210	285	575	2200	43
,, 735–10	,, 735–10	250	340	580	2430	48
,, 841–10	,, 841–10	300	410	580	2760	54
,, 843–10	,, 843–10	360	490	585	3050	60
No-lood speed 500 rpm.						
DHE 655–12	DKE 655–12	110	150	475	1780	35
,, 731–12	,, 731–12	135	185	475	1970	39
,, 733–12	,, 733–12	160	220	475	2200	43
,, 735–12	,, 735–12	190	260	480	2430	48
,, 841–12	,, 841–12	220	300	480	2660	54
,, 843–12	,, 843–12	280	380	480	3050	60
,, 845–12	,, 845–12	310	420	485	3570	70

Principle diagrams on request.

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



THREE-PHASE MOTORS

with squirrel-cage rotor

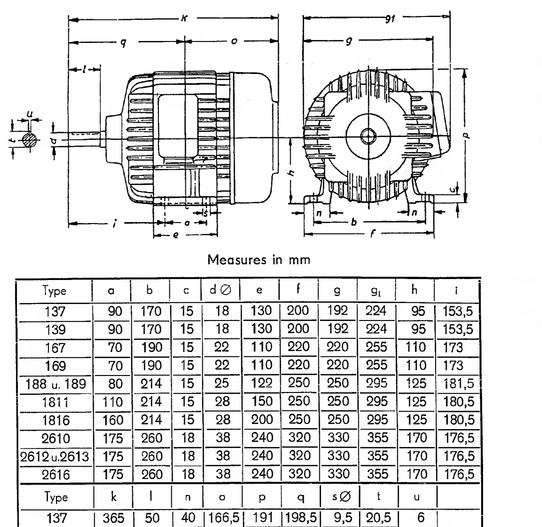
surface-cooled

Design B 3 Protective system P 33

Three-phase motors with squirrel-cage rotor, surface-cooled
Protective system P 33
Anti-friction bearing, design B 3, free shaft stump

Type	Capacity		Rated speed	Rated current at 380 volts	Efficiency	Power factor	Approx. weight	
RM	kW	HP	rpm.	obt. amp.	%	cos φ	kg	lbs.
No-load speed 3000 rpm.								
137/2	1,1	1,5	2810	2,7	78	0,8	25	55
139/2	1,5	2	2840	3,2	80	0,82	28,5	63
169/2	2,2	3	2840	4,85	81,5	0,84	29	64
189/2	3	4	2840	6,6	81,5	0,84	44	97
1811/2	4	5,5	2840	8,6	83	0,85	51,6	113
1816/2	5,5	7,5	2870	11,8	84	0,85	65	143
No-load speed 1500 rpm.								
137/4	0,55	0,75	1400	1,55	70	0,72	25	55
139/4	0,75	1	1400	2	75	0,73	28,5	63
167/4	1,1	1,5	1400	2,8	78,5	0,76	27,5	61
169/4	1,5	2	1400	3,55	80	0,8	29	64
188/4	2,2	3	1415	5	81	0,82	44	97
1811/4	3	4	1420	6,6	83	0,83	50,6	111
1816/4	4	5,5	1425	8,7	84	0,83	61,6	135
2610/4	5,5	7,5	1435	11,7	85	0,84	88,5	195
2613/4	7,5	10	1435	15,6	86	0,85	106	234
2616/4	10	13,5	1440	20,7	86	0,85	13	28
No-load speed 1000 rpm.								
167/6	0,66	0,9	910	2	71	0,70	27,5	61
169/6	0,88	1,2	915	2,48	74	0,73	29	64
188/6	1,5	2	920	3,9	76	0,73	44	97
1812/6	2,2	3	950	5.65	80	0.74	52	114
1816/6	3	4	940	7,8	78	0,73	65	143
2610/6	4	5,5	940	10,5	80	0,75	88,5	195
2613/6	5,5	7,5	940	13,3	81,5	0,77	106	234
2616/6	7	9,5	945	14,8	81,5	0,8	138	304
No-load speed 750 rpm. (to be constructed)								

The power figures of our table refer to continuous service at the standard voltages of 220, 380 and 500 volts and at a frequency of 50 c.p.s. This also refers to the number of turns (speed).
The motors have a terminal box with two thread holes for the connection of steel armoured cable terminals. Bearing plates and casing of grey cast iron or cast aluminium. The rotor has ball bearings with grease lubrication. As to the rest, both the insulation and the design, answer the general regulations of the VDE (German Engineers).

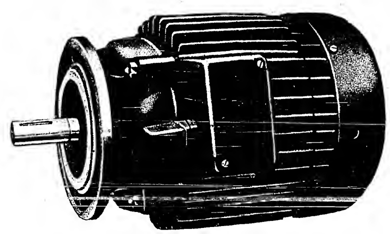


Measures in mm

Type	a	b	c	d ∅	e	f	g	g_1	h	i
137	90	170	15	18	130	200	192	224	95	153,5
139	90	170	15	18	130	200	192	224	95	153,5
167	70	190	15	22	110	220	220	255	110	173
169	70	190	15	22	110	220	220	255	110	173
188 u. 189	80	214	15	25	122	250	250	295	125	181,5
1811	110	214	15	28	150	250	250	295	125	180,5
1816	160	214	15	28	200	250	250	295	125	180,5
2610	175	260	18	38	240	320	330	355	170	176,5
2612 u.2613	175	260	18	38	240	320	330	355	170	176,5
2616	175	260	18	38	240	320	330	355	170	176,5
Type	k	l	n	o	p	q	s ∅	t	u	
137	365	50	40	166,5	191	198,5	9,5	20,5	6	
139	365	50	40	166,5	191	198,5	9,5	20,5	6	
167	378	60	42	170	220	208	11,5	24,5	6	
169	378	60	42	170	220	208	11,5	24,5	6	
188 u. 189	398	60	48	176,5	250	221,5	14	28	8	
1811 u.1812	426	60	48	190,5	250	235,5	14	31	8	
1816	476	60	48	215,5	250	260,5	14	31	8	
2610	457	90	60	193	335	264	18	41,5	10	
2612 u 2613	527	90	60	228	335	299	18	41.5	10	
2616	527	90	60	228	335	299	18	41,5	10	

Fit for d = JSAj 6; deviation for h = −0,05; set spring according to DIN 6885.

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



THREE-PHASE MOTORS
WITH SQUIRREL-CAGE ROTOR

surface-cooled

Design B 5 and V 1

Protective system P 33

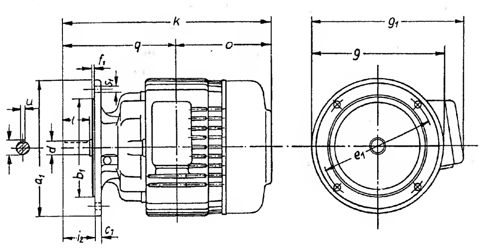
Three-phase motors with squirrel-cage rotor, surface-cooled

Protective system P 33

Anti-friction bearing, design B 5 and V 1, free shaft stump

Type	Capacity		Rated speed	Rated current at 380 volts	Efficiency	Power factor	Approx. weight	
RM	kw	HP	rpm.	abt. amp.	%	cos φ	kg	lbs.
No-load speed 3000 rpm.								
137/2	1,1	1,5	2810	2,7	78	0,8	25	55
139/2	1,5	2	2840	3,2	80	0,82	28,5	63
169/2	2,2	3	2840	4,85	81,5	0,84	29	64
189/2	3	4	2840	6,6	81,5	0,84	44	97
1811/2	4	5,5	2840	8,6	83	0,85	51.6	113
1816/2	5,5	7,5	2860	11,8	84	0,85	61	134
No-load speed 1500 rpm.								
137/4	0,55	0,75	1400	1,55	70	0,72	25	55
139/4	0,75	1	1400	2	75	0,73	28,5	63
167/4	1,1	1,5	1400	2,8	78,5	0,76	2,75	61
169/4	1,5	2	1400	3,55	80	0,8	29	64
188/4	2,1	3	1425	5	81	0,82	44	97
1811/4	3	4	1420	6,6	83	0,83	50,6	111
1816/4	4	5,5	1425	8,7	84	0,83	61,6	135
2610/4	5,5	7,5	1435	11,7	85	0,84	88,5	195
2613/4	7,5	10	1435	15,6	86	0,85	102,5	227
2616/4	10	13,5	1440	20,7	86	0,85	134,5	296
No-load speed 1000 rpm.								
167/6	0,66	0,9	910	2	71	0,70	27,5	61
169/6	0,88	1,2	915	2,48	74	0,73	29	64
188/6	1.5	2	920	3,9	76	0,73	44	97
1812/6	2,2	3	950	5,65	80	0,74	52	114
1816/6	3	4	940	7,8	78	0,73	61,6	135
2610/6	4	5,5	940	10,5	80	0,75	88,5	195
2613/6	5,5	7,5	940	13,3	81,5	0,77	102,5	227
2616/6	6	9,5	945	14,8	81,5	0,8	134,5	296
No-load speed 750 rpm. (to be constructed)								

The power figures of our table refer to continuous service as the standard voltages of 220. 380 and 500 volts and at a frequency of 50 c.p.s. This also refers to the number of turns (speed).
The motors have a terminal box with two thread holes for the connection of steel armoured cable terminals. Bearing plates and casing of grey cast iron or cast aluminium. The rotor has ball bearings with grease lubrication. As to the rest, both the insulation and the design, answer the general regulations of the VDE (German Engineers).

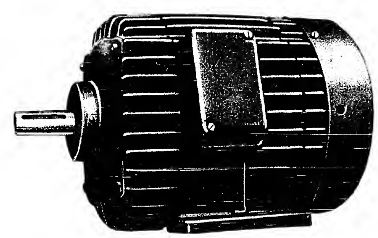


Measures in mm

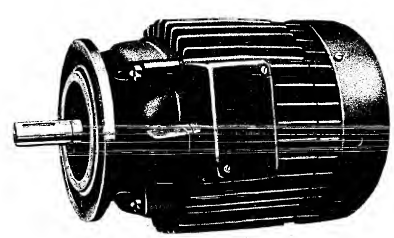
Type	$a_1 \varnothing$	$o_1 \varnothing$	c_1	$d \varnothing$	$e_1 \varnothing$	f	g	g_1	i_2	k
137	160	110	10	18	130	3,5	192	224	58	365
139	160	110	10	18	130	3,5	192	224	58	365
167	200	130	11	22	165	3,5	220	255	68	378
169	200	130	11	22	165	3,5	220	255	68	378
188 u. 189	250	180	12,5	25	215	3,5	250	295	68	398
1811 u.1812	250	180	12,5	28	215	3,5	250	295	68	426
1816	250	180	12,5	28	215	3,5	250	295	68	476
2610	350	250	20	38	300	4	330	355	85	457
2612 u.2613	350	250	20	38	300	4	330	355	85	527
2616	350	250	20	38	300	4	330	355	85	527
Type	l	o	q	$s_1 \varnothing$	t	u				
137	50	166,5	198,5	9,5	20,5	6				
139	50	166,5	198,5	9,5	20,5	6				
167	60	170	208	11,5	24,5	6				
169	60	170	208	11,5	24,5	6				
188 u. 189	60	176,5	221,5	14	28	8				
1811 u. 1812	60	190,5	235,5	14	31	8				
1816	60	215,5	260,5	14	31	8				
2610	90	193	264	18	41,5	10				
2612 u.2613	90	228	299	18	41,5	10				
2616	90	228	299	18	41,5	10				

Fit for d and b_2 = JSAj 6; set spring according to DIN 6885.

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



Design B 3



Design B 5, V 1, B 5/B 3

POLE-CHANGING THREE-PHASE MOTORS

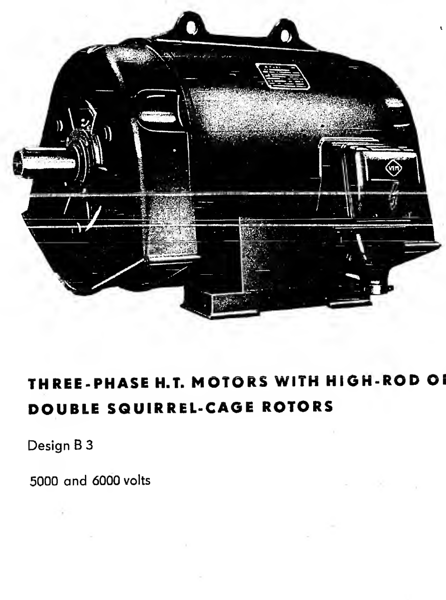
with squirrel-cage rotor

surface-cooled Protective system P 33

1 — a 1.97

Type	Capacity		Rated speed	Rat. current at 220 volts	Efficiency	Power factor	Approx. weight kg		Approx. weight lbs.	
RM a. RF	kW	HP	rpm.	amp.	%	$\cos \varphi$	RM	RF	RM	RF
No-load speed 1500/3000 rpm.										
139/4/2	0,6/0,8	0,8/1,1	1400/2820	2,85/3,83	75	0,75	28,5	28,5	63	63
167/4/2	0,8/1,1	1,1/1,5	1410/2830	3,35/4,65	79	0,80	27,5	27,5	61	61
169/4/2	1,1/1,5	1,5/2	1410/2830	4,5/6,1	79,5	0,81	29	29	64	64
188/4/2	1,8/2,2	2,5/3	1430/2860	7,5/8,7	79	0,81	44	44	97	97
1811/4/2	2,4/3	3,3/4	1420/2850	10/12	77	0,82	50,6	50,6	111	111
1816/4/2	3,5/4,2	4,8/5,7	1430/2860	13,3/14,8	83	0,83	61,6	61,6	135	135
2612/4/2	6,5/7,5	8,8/10	1430/2860	24,5/27,2	83	0,84	100,5	104	221	229
2616/4/2	8,5/10	11,5/13,5	1440/2870	32/34,6	82	0,85	135,5	138	296	304

Other capacities on request. Measures according to the above table of normal types RM and RF.



THREE-PHASE H.T. MOTORS WITH HIGH-ROD OR DOUBLE SQUIRREL-CAGE ROTORS

Design B 3

5000 and 6000 volts

Three-phase H. T. motors for 5000 and 6000 volts

Anti-friction bearing, design B 3, free shaft stump

With high-rod rotor type	With double squirrel-cage rotor type	Capacity kW	Capacity abt. HP	Rated speed rpm.	Approx. weight kg	Approx. weight cwts.
No-load speed 1500 rpm.						
DHE 651–4	DKE 651–4	130	175	1470	1440	28
„ 653–4	„ 653–4	170	230	1470	1590	31
„ 655–4	„ 655–4	200	270	1470	1780	35
„ 731–4	„ 731–4	250	340	1470	1970	39
„ 733–4	„ 733–4	320	435	1470	2200	43
„ 735–4	„ 735–4	380	515	1470	2430	48
„ 841–4	„ 841–4	450	610	1470	2760	54
„ 843–4	„ 843–4	550	750	1470	3050	60
„ 845–4	„ 845–4	660	900	1470	3570	70
„ 981–4	„ 981–4	840	1140	1470	3850	76
„ 983–4	„ 983–4	1000	1360	1470	4260	84
„ 985–4	„ 985–4	1200	1630	1470	5060	99
No-load speed 1000 rpm.						
DHE 653–6	DKE 653–6	130	175	985	1590	31
„ 655–6	„ 655–6	165	225	985	1780	35
„ 731–6	„ 731–6	180	245	985	1970	39
„ 733–6	„ 733–6	240	325	985	2200	43
„ 735–6	„ 735–6	280	380	985	2430	48
„ 841–6	„ 841–6	340	460	985	2760	54
„ 843–6	„ 843–6	410	560	985	3050	60
„ 845–6	„ 845–6	500	680	985	3570	70
„ 981–6	„ 981–6	650	885	985	3850	76
„ 983–6	„ 983–6	820	1115	985	4260	84
„ 985–6	„ 986–6	920	1250	985	5060	99

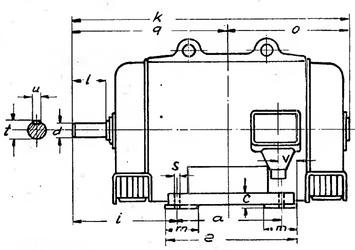
Protective systems: Size of design 651 . . . 735 P 12, P 22
841 . . . 985 P 11, P 21

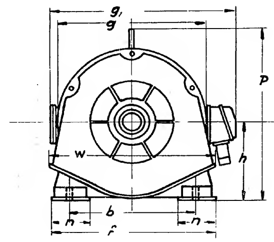
Three-phase H. T. motors for 5000 and 6000 volts

Anti-friction bearing, design B 3, free shaft stump

With high-rod rotor Type	With double squirrel-cage rotor Type	Capacity kW	Capacity abt. HP	Rated speed rpm.	Approx weight kg	Approx weight cwts.
No-load speed 750 rpm.						
DHE 731–8	DKE 731–8	140	190	735	1970	39
„ 733–8	„ 733–8	170	230	735	2200	43
„ 735–8	„ 735–8	220	300	735	2430	48
„ 841–8	„ 841–8	250	340	735	2760	54
„ 843–8	„ 843–8	300	410	735	3050	60
„ 845–8	„ 845–8	370	505	735	3570	70
„ 981–8	„ 981–8	440	600	735	3850	76
„ 983–8	„ 983–8	530	720	735	4260	84
„ 985–8	„ 985–8	640	870	735	5060	99
No-load speed 600 rpm.						
DHE 841–10		200	270	560	2760	54
„ 843–10		260	355	560	3050	60
„ 845–10		320	435	560	3570	70
„ 981–10		350	475	560	3850	76
„ 983–10		400	545	560	4260	84
„ 985–10		500	680	560	5060	99
No-load speed 500 rpm.						
DHE 841–12		140	190	450	2760	54
„ 843–12		180	245	450	3050	60
„ 845–12		230	315	450	3570	70
„ 981–12		280	380	450	3850	76
„ 983–12		330	450	450	4260	84
„ 985–12		400	545	450	5060	99

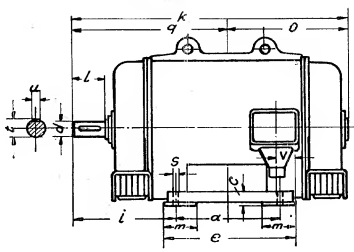
Protective systems: Size of design 651 . . . 735 P 12, P 22
841 . . . 985 P 11, P 21

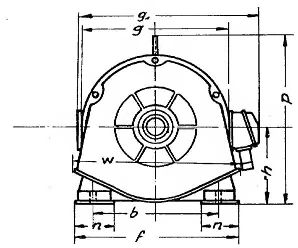




Größe = Size   Shaft stump m_6 Bore of the coupling H 7

Größe	a	b	c	d	e	f	g_1	g	h	i	k	l	m	n	o	p	q	s	t	u	v
651–4	530	710	82	100	690	900	1155	854	450	628	1540	210	190	190	647	990	893	28	106	28	115
8																					
10																					
12																					
653–4	600	710	82	100	760	900	1155	854	450	628	1610	210	190	190	682	1000	928	28	106	28	115
6	530	710	82	100	690	900	1155	854	450	628	1540	210	190	190	647	1000	893	28	106	28	115
8																					
10																					
12																					
655–4	670	710	82	100	830	900	1155	854	450	628	1680	210	190	190	717	1000	963	28	106	28	115
6	600	710	82	100	760	900	1155	854	450	628	1610	210	190	190	682	1000	928	28	106	28	115
8																					
10																					
12																					





Größe = Size   Shaft stump m_6 Bore of the coupling H 7

Größe	a	b	c	d	e	f	g_1	g	h	i	k	l	m	n	o	p	q	s	t	u	v
731–4	600	800	87	110	760	1010	1200	965	500	675	1697	210	210	210	722	1110	975	28	116	28	115
6	530	800	87	110	690	1010	1200	965	500	675	1627	210	210	210	687	1110	940	28	116	28	115
8	530	800	87	110	690	1010	1200	965	500	675	1627	210	210	210	687	1110	940	28	116	28	115
10																					
12																					
733–4	670	800	87	110	830	1010	1200	965	500	675	1767	210	210	210	757	1110	1010	28	116	28	115
6	600	800	87	110	760	1010	1200	965	500	675	1697	210	210	210	722	1110	975	28	116	28	115
8	530	800	87	110	690	1010	1200	965	500	675	1627	210	210	210	687	1110	940	28	116	28	115
10																					
12																					
735–4	750	800	87	110	910	1010	1200	965	500	675	1847	210	210	210	797	1110	1050	28	116	28	115
6	670	800	87	110	830	1010	1200	965	500	675	1767	210	210	210	757	1110	1010	28	116	28	115
8	670	800	87	110	830	1010	1200	965	500	675	1767	210	210	210	757	1110	1010	28	116	28	115
10																					
12																					

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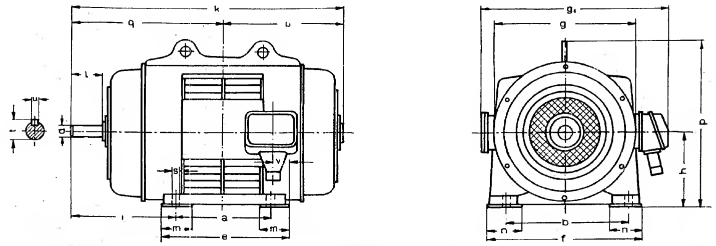
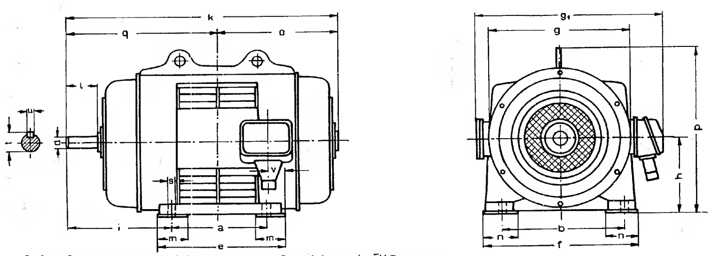


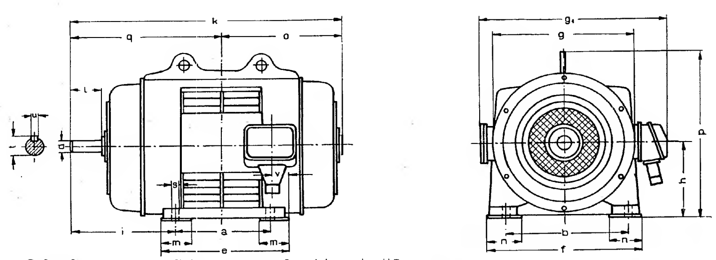
Größe = Size   Shaft stump m_6 Bore of the coupling H 7

Größe	a	b	c	d	e	f	g_1	g	h	i	k	l	m	n	o	p	q	s	t	u	v
841–4	750	900	97	120	1100	1150	1370	1080	560	689	1864	210	250	250	800	1230	1064	40	126,8	32	237
6	670	900	97	120	1020	1150	1370	1080	560	689	1784	210	250	250	760	1230	1024	40	126.8	32	237
8	670	900	97	120	1020	1150	1370	1080	560	689	1784	210	250	250	760	1230	1024	40	126,8	32	237
10	670	900	97	120	1020	1150	1370	1080	560	689	1784	210	250	250	760	1230	1024	40	126,8	32	237
12	670	900	97	120	1020	1150	1370	1080	560	689	1784	210	250	250	760	1230	1024	40	126,8	32	237
843–4	850	900	97	120	1200	1150	1370	1080	560	689	1964	210	250	250	850	1230	1114	40	126,8	32	237
6	750	900	97	120	1100	1150	1370	1080	560	689	1864	210	250	250	800	1230	1064	40	126,8	32	237
8	750	900	97	120	1100	1150	1370	1080	560	689	1864	210	250	250	800	1230	1064	40	126,8	32	237
10	750	900	97	120	1100	1150	1370	1080	560	689	1864	210	250	250	800	1230	1064	40	126,8	32	237
12	750	900	97	120	1100	1150	1370	1080	560	689	1864	210	250	250	800	1230	1064	40	126,8	32	237
845–4	950	900	97	120	1300	1150	1370	1080	560	689	2064	210	250	250	900	1230	1164	40	126,8	32	237
6	850	900	97	120	1200	1150	1370	1080	560	689	1964	210	250	250	850	1230	1114	40	126,8	32	237
8	850	900	97	120	1200	1150	1370	1080	560	689	1964	210	250	250	850	1230	1114	40	126,8	32	237
10	850	900	97	120	1200	1150	1370	1080	560	689	1964	210	250	250	850	1230	1114	40	126,8	32	237
12	850	900	97	120	1200	1150	1370	1080	560	689	1964	210	250	250	850	1230	1114	40	126,8	32	237



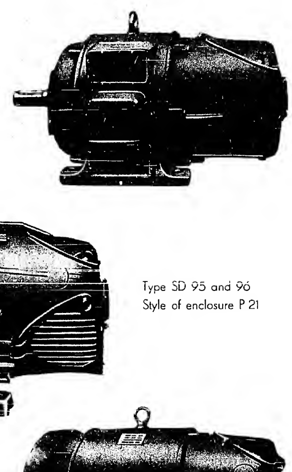
Größe = Size   Shaft stump m_6 Bore of the coupling H 7

Größe	o	b	c	d	e	f	g_1	g	h	i	k	l	m	n	a	p	q	s	t	u	v
981–4	750	1000	102	130	1080	1270	1520	1220	630	780	2005	250	270	270	850	1395	1155	50	136,8	32	237
6	750	1000	102	130	1080	1270	1520	1220	630	780	2005	250	270	270	850	1395	1155	50	136,8	32	237
8	750	1000	102	130	1080	1270	1520	1220	630	780	2005	250	270	270	850	1395	1155	50	136,8	32	237
10	670	1000	102	130	1000	1270	1520	1220	630	780	1925	250	270	270	810	1395	1115	50	136,8	32	237
12	670	1000	102	130	1000	1270	1520	1220	630	780	1925	250	270	270	810	1395	1115	50	136,8	32	237
983–4	850	1000	102	130	1180	1270	1520	1220	630	780	2105	250	270	270	900	1395	1205	50	136,8	32	237
6	850	1000	102	130	1180	1270	1520	1220	630	780	2105	250	270	270	900	1395	1205	50	136,8	32	237
8	850	1000	102	130	1180	1270	1520	1220	630	780	2105	250	270	270	900	1395	1205	50	136,8	32	237
10	750	1000	102	130	1080	1270	1520	1220	630	780	2005	250	270	270	850	1395	1155	50	136,8	32	237
12	750	1000	102	130	1080	1270	1520	1220	630	780	2005	250	270	270	850	1395	1155	50	136,8	32	237
985–4	950	1000	102	130	1280	1270	1520	1220	630	780	2205	250	270	270	950	1395	1255	50	136,8	32	237
6	950	1000	102	130	1280	1270	1520	1220	630	780	2205	250	270	270	950	1395	1255	50	136,8	32	237
8	950	1000	102	130	1280	1270	1520	1220	630	780	2205	250	270	270	950	1395	1255	50	136,8	32	237
10	850	1000	102	130	1180	1270	1520	1220	630	780	2105	250	270	270	900	1395	1205	50	136,8	32	237
12	850	1000	102	130	1180	1270	1520	1220	630	780	2105	250	270	270	900	1395	1205	50	136,8	32	237

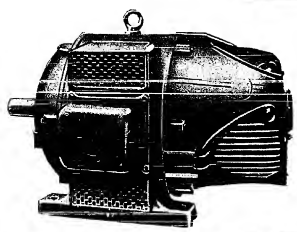


Große = Size   Shaft stump m_6 Bore of the coupling H 7

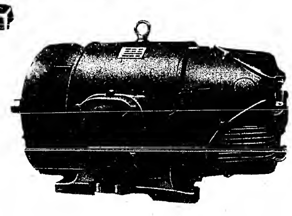
Große	a	b	c	d	e	f	g_1	g	h	i	k	l	m	n	o	p	q	s	t	u	v
981–4	750	1000	102	130	1080	1270	1520	1220	630	780	2005	250	270	270	850	1395	1155	50	136,8	32	237
6	750	1000	102	130	1080	1270	1520	1220	630	780	2005	250	270	270	850	1395	1155	50	136,8	32	237
8	750	1000	102	130	1080	1270	1520	1220	630	780	2005	250	270	270	850	1395	1155	50	136,8	32	237
10	670	1000	102	130	1000	1270	1520	1220	630	780	1925	250	270	270	810	1395	1115	50	136,8	32	237
12	670	1000	102	130	1000	1270	1520	1220	630	780	1925	250	270	270	810	1395	1115	50	136,8	32	237
983–4	850	1000	102	130	1180	1270	1520	1220	630	780	2105	250	270	270	900	1395	1205	50	136,8	32	237
6	850	1000	102	130	1180	1270	1520	1220	630	780	2105	250	270	270	900	1395	1205	50	136,8	32	237
8	850	1000	102	130	1180	1270	1520	1220	630	780	2105	250	270	270	900	1395	1205	50	136,8	32	237
10	750	1000	102	130	1080	1270	1520	1220	630	780	2005	250	270	270	850	1395	1155	50	136,8	32	237
12	750	1000	102	130	1080	1270	1520	1220	630	780	2005	250	270	270	850	1395	1155	50	136,8	32	237
985–4	950	1000	102	130	1280	1270	1520	1220	630	780	2205	250	270	270	950	1395	1255	50	136,8	32	237
6	950	1000	102	130	1280	1270	1520	1220	630	780	2205	250	270	270	950	1395	1255	50	136,8	32	237
8	950	1000	102	130	1280	1270	1520	1220	630	780	2205	250	270	270	950	1395	1255	50	136,8	32	237
10	850	1000	102	130	1180	1270	1520	1220	630	780	2105	250	270	270	900	1395	1205	50	136,8	32	237
12	850	1000	102	130	1180	1270	1520	1220	630	780	2105	250	270	270	930	1395	1205	50	136,8	32	237



Type SD 75 ... 86
Style of enclosure P 21



Type SD 95 and 96
Style of enclosure P 21



Style of enclosure P 22
Type SD 105 ... 117

Sachsenwerk Niedersedlitz

THREE PHASE CURRENT MOTORS WITH SLIP RING INDUCTION ROTOR

Style of enclosure P 21 and P 22

Design B 3

Three-phase current motors with slip ring induction rotor

Style of enclosure: P 21 up to size 96, terminal covering P 22
P 22 from size 105, terminol covering P 43
Anti-friction bearing, design B 3, free shoft stump

Type	Copo-city	Speed	Nominol current ot 380 volts	Effi-ciency	Copo-city foctor	Rotor dotes		Weight obout	
	kW	rpm	A	%	cos φ	V	A	kg	Cwts.
Lost motion speed 1500 rpm									
SD 75–4	34	1450	67	87,5	0,88	290	73	380	7.2.0
SD 76–4	42	1450	82	88	0,88	365	73	425	8.2.0
SD 85–4	55	1450	106	88,5	0,89	245	140	507	10.0.0
SD 86–4	70	1455	134	89	0,89	300	145	577	11.2.0
SD 95–4	100	1460	190	90	0,89	270	230	750	15.0.0
SD 96–4	125	1460	234	90,5	0,89	335	230	835	16.2.0
SD 105–4	160	1460	297	91	0,90	355	285	1170	23.0.0
SD 106–4	200	1460	370	91,5	0,90	430	290	1340	26.1.0
SD 107–4	250	1460	455	92	0,90	540	290	1520	30.0.0
SD 115–4	320	1465	580	92,5	0,91	450	435	1855	36.2.0
SD 116–4	400	1465	720	93	0,91	515	470	2100	41.0.0
SD 117–4	500	1470	895	93,5	0,91	650	470	2380	47.0.0

From type SD 95–4 upwards for direct coupling only

Three-phase current motors with slip ring induction rotor

Style of enclosure: P 21 up to size 96, terminol covering P 22
P 22 from size 105, terminol covering P 43
Anti-friction beoring, design B 3, free shaft stump

Type	Copa-city	Speed	Nominol current ot 380 volts	Effi-ciency	Capo-city foctor	Rotor dotes		Weight about	
	kW	rpm	A	%	cos φ	V	A	kg	Cwts.
Lost motion speed 1000 rpm									
SD 75–6	23	950	47	86	0,86	335	45	380	7.2.0
SD 76–6	30	950	60	87	0,86	415	47	425	8.2.0
SD 85–6	40	950	80	87,5	0,87	220	120	507	10.0.0
SD 86–6	50	950	99	88	0,87	270	120	577	11.2.0
SD 95–6	70	965	136	88,5	0,88	220	195	750	15.0.0
SD 96–6	90	965	173	89,5	0,88	275	205	835	16.2.0
SD 105–6	110	965	208	90	0,89	275	255	1170	23.0.0
SD 106–6	135	965	254	91	0,89	320	265	1340	26.1.0
SD 107–6	170	970	314	91,5	0,89	410	260	1520	30.0.0
SD 115–6	220	975	405	92	0,90	450	300	1855	36.2.0
SD 116–6	265	975	485	92,5	0,90	515	315	2100	41.0.0
SD 117–6	330	975	600	93	0,90	655	310	2380	47.0.0

From type SD 106–6 upwords for direct coupling only

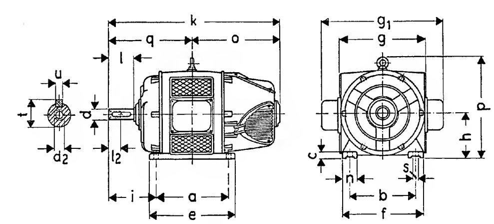
Three-phase current motors with slip ring induction rotor

Style of enclosure: P 21 up to size 96, terminal covering P 22
P 22 from size 105, terminal covering P 43

Anti-friction bearing, design B 3, free shaft stump

Type	Capa-city	Speed	Nominal current at 380 volts	Effi-ciency	Capa-city factor	Rotor dates		Weight about	
	kW	rpm	A	%	cos φ	V	A	kg	Cwts.
Lost motion speed 750 rpm									
SD 75–8	18	710	38	85	0,84	170	68	380	7.2.0
SD 76–8	22	710	46	85,5	0,84	215	68	425	8.2.0
SD 85–8	30	715	62	86	0,85	230	82	507	10.0.0
SD 86–8	37	715	76	87	0,85	290	82	577	11.2.0
SD 95–8	50	720	100	88	0,86	290	110	750	15.0.0
SD 96–8	64	720	127	88,5	0,86	365	110	835	16.2.0
SD 105–8	80	720	158	89	0,86	240	210	1170	23.0.0
SD 106–8	100	720	197	90	0,86	275	230	1340	26.1.0
SD 107–8	125	725	242	90,5	0,87	365	225	1520	30.0.0
SD 115–8	160	730	302	91,5	0,87	405	245	1855	36.2.0
SD 116–8	200	730	376	92	0,88	540	230	2100	41.0.0
SD 117–8	250	730	456	92,5	0,88	650	240	2380	47.0.0

From type SD 116–8 upwards for direct coupling only



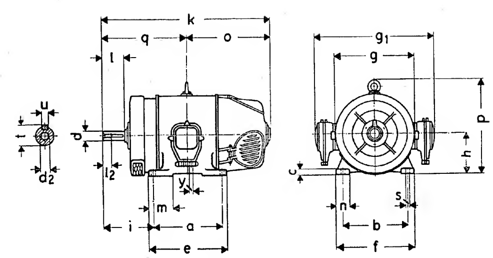
Size	a	b	c	e	f	g	g_1	h*)	i	k	n	o	p	q	s ∅
75	370	385	38	440	480	500	703	260	285	1024	95	554	585	470	23
76	430	385	38	500	480	500	703	260	315	1114	95	584	585	530	23
85	440	435	40	520	540	565	765	280	330	1205	105	655	650	550	27
86	500	435	40	580	540	565	765	280	330	1265	105	685	650	580	27
95	500	510	50	590	620	650	935	340	320	1215	110	645	760	570	27
96	570	510	50	660	620	650	935	340	350	1315	110	680	760	635	27

Size	Shaft stump					
	d**)	l	u	t	d_2	l_2
75	55	110	16	58,5	M 20	53
76	60	140	18	64,2	M 20	53
85	65	140	18	69,2	M 20	53
86	70	140	20	74,6	M 20	53
95	75	140	20	79,6	M 20	53
96	80	170	22	85,5	M 20	53

*) Admissible deviation h = minus 1 mm

**) Fit: ISA m 6 according to DIN 7160 sheet 3

Measures in mm



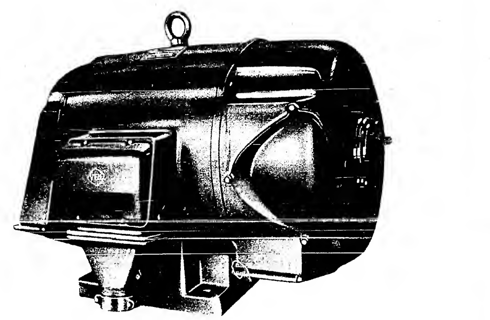
Size	a	b	c	e	f	g	g_1	h*)	i	k	m	n	o	p	q
105	540	650	60	630	770	780	1225	400	460	1475	200	125	745	910	730
106	610	650	60	700	770	780	1225	400	460	1545	220	125	780	910	765
107	710	650	60	800	770	780	1225	400	460	1645	250	125	830	910	815
115	600	750	62	700	880	900	1345	450	535	1670	200	140	835	1040	835
116	670	750	62	770	880	900	1345	450	535	1740	230	140	870	1040	870
117	770	750	62	870	880	900	1345	450	535	1840	270	140	920	1040	920

			Shaft stump					
Size	s	y ∅	d**)	l	t	u	d_2	l_2
105	27	60	85	170	90,5	22	M 20	53
106	27	60	90	170	95,3	25	M 24	63
107	27	60	95	170	100,3	25	M 24	63
115	33	60	100	210	106,1	28	M 24	63
116	33	60	100	210	106,1	28	M 24	63
117	33	60	100	210	106,1	28	M 24	63

*) Admissible deviation h = minus 1 mm (abt. $^3/_{64}$ inch.)

**) Fit: ISA m 6 according to DIN 7160 sheet 3

Measures in mm



THREE-PHASE MOTORS WITH SLIP RING ROTOR

Design B 3

Protective system P 12

Sanitized Copy Approved for Release 2010/08/18 : CIA-RDP81-01043R000400210006-4

Three-phase motors with slip ring rotor

Protective system P 12

Anti-friction bearing, design B 3, free shaft stump

Type	Capacity kW	Capacity HP	Speed abt. rpm.	Rated current at 380 volts abt. rpm.	Efficiency abt. %	Power factor cos φ abt.	Rotor dates obt. volts	Rotor dates obt. amp.	Approx. weight kg	Approx. weight cwts.
No-load speed 3000 rpm.										
S 8/2	20	27	2830	40	86,5	0,88	237	52,4	180	3.2.4
S 9/2	28	38	2850	55,5	87	0,88	349	49,7	200	3.3.21
S 10/2	38	52	2880	75	87,5	0,83	127	185	280	5.2.1
S 11/2	50	68	2880	97	88	0,89	175	176	340	6.2.22
S 12/2	63	86	2890	121	88,5	0,89	190	205	480	9.1.22
S 13/2	80	109	2890	152	88,5	0,90	225	217	570	11.0.24
S 14/2	100	136	2900	190	89	0,90	342	180	720	14.0.22
S 15/2	125	170	2900	236	89,5	0,90	410	188	810	15.3.22
S 16/2	160	218	2920	298	89,6	0,91	432	229	890	17.2.2
S 17/2	200	272	2920	371	90	0,91	547	226	1100	21.2.17
S 18/2	250	340	2930	460	90,5	0,91	410	377	1320	26.0.0
S 19/2	315	428	2930	581	90,5	0,91	513	380	1500	29.2.3

Available as foot motors according to design B 3 with short circuit and brush lifting device or with permanently sliding brushes. At regular working with constant torque the capacity of types has to be reduced for about 10% and 20% at a speed reduction of about 20% resp. 50%. For other figures inquiry is recommended.

Standard voltages of the motors 220, 380 and 500 volts, 50 c. p. s. In case of other voltages and frequencies please write for the corresponding dates.

Three-phase motors with slip ring rotor

Protective system P 12

Anti-friction bearing, design B 3, free shaft stump

Type	Capacity kW	Capacity HP	Speed abt. rpm.	Rated current at 380 volts abt. rpm.	Efficiency obt. %	Power factor cos φ abt	Rotor dates abt. volts	Rotor dates abt. amp.	Approx. Weight kg	Approx. Weight cwts.
No-load speed 1500 rpm.										
S 8/4	14	19	1420	29	86,5	0,85	200	43,3	180	3 2.4
S 9/4	20	27	1420	40,5	87,5	0.86	266	46,5	200	3.3.21
S 10/4	28	38	1430	56	88	0,86	189	92	280	5.2.1
S 11/4	38	52	1430	75	88,5	0,87	257	91,5	340	6.2.22
S 12/4	50	68	1440	98,5	88,5	0,87	147	210	480	9.1.22
S 13/4	63	86	1440	122	89	0,88	171	227	570	11.0.24
S 14/4	80	109	1450	153	89,5	0,89	274	181	720	14.0.22
S 15/4	100	136	1450	190	90	0,89	344	179	810	15.3.22
S 16/4	125	170	1460	233	90,5	0,90	274	280	890	17.2.2
S 17/4	160	218	1460	298	90,5	0,90	357	274	1100	21.2.17
S 18/4	200	272	1460	371	91	0,90	357	347	1320	26.0.0
S 19/4	250	340	1460	464	91	0,90	455	340	1500	29.2.3

Available as foot motors according to design B 3 with short circuit and brush lifting device or with permanently sliding brushes. At regular working with constant torque the capacity of types has to be reduced for about 10% and 20% at a speed reduction of about 20% resp. 50%. For other figures inquiry is recommended.

Standard voltages of the motors 220, 380 and 500 volts, 50 c. p. s. In case of other voltages and frequencies please write for the corresponding dates.

Design C 2 available at extra charge .

Three-phase motors with slip ring rotor

Protective system P 12

Anti-friction bearing, design B 3, free shaft stump

Type	Capacity kW	Capacity HP	Speed obt.rpm.	Rated current at 380 volts obt. rpm.	Efficiency obt. %	Power factor cos φ obt.	Rotor dates obt. volts	Rotor dates obt. amp.	Approx. weight kg	Approx. weight cwts.
No-load speed 1000 rpm.										
S 8/6	10	13,6	940	21,5	85	0,83	273	25,4	180	3.2.4
S 9/6	14	19	940	29.5	86	0.84	322	26,8	200	3.3.21
S 10/6	20	27	950	41	87	0,85	274	45	280	5.2.1
S 11/6	28	38	950	57	87,5	0,85	368	45	340	6.2.22
S 12/6	38	52	950	76	88	0,86	154	153	480	9.1.22
S 13/6	50	68	960	100	88,5	0,86	193	161	570	11.0.24
S 14/6	63	86	960	124	89	0,87	220	177	720	14.0.22
S 15/6	80	109	960	156	89,5	0,87	280	177	810	15.3.22
S 16/6	100	136	960	190	90	0,89	308	202	890	17.2.2
S 17/8	125	170	965	235	90,5	0,89	342	224	1100	21.2.17
S 18/6	160	218	965	298	90,5	0,9	362	274	1320	26.0.0
S 19/6	200	272	970	372	91	0,9	473	262	1500	29.2.3

Available as foot motors according to design B 3 with short circuit and brush lifting device or with permanently sliding brushes. At regular working with constant torque the capacity of types has to be reduced for about 10% and 20% at a speed reduction of about 20% resp. 50%. For other figures inquiry is recommended.

Standard voltages of the motors 220, 380 and 500 volts, 50 c. p. s. In case of other voltages and frequencies please write for the corresponding dates.

Design C 2 available at extra charge.

Three-phase motors with slip ring rotor

Protective system P 12

Anti-friction bearing, design B 3, free shaft stump

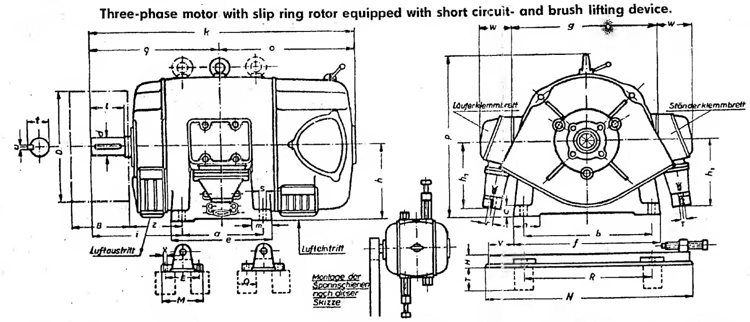
Type	Capacity kW	Capacity HP	Speed obt.rpm.	Rated current at 380 volts obt. rpm.	Efficiency obt. %	Power factor cos. φ obt.	Rotor dates obt. volts	Rotor dates obt. amp.	Approx. weight kg	Approx. weight cwts.
No-load speed 750 rpm.										
S 8/8	7	9,5	710	16,5	82,5	0,78	140	31	180	3.2.4
S 9/8	10	13,6	710	23	84	0,79	176	35	200	3.3.21
S 10/8	14	19	715	31,3	85	0,80	212	41	280	5.2.1
S 11/8	20	27	715	43,5	86	0,81	287	43	340	6.2.22
S 12/8	28	38	715	60	86,5	0,82	180	96	480	9.1.22
S 13/8	38	52	715	81	87	0,82	220	107	570	11.0.24
S 14/8	50	68	720	104	87,5	0,83	133	232	720	14.0.22
S 15/8	63	86	720	131	88	0,83	167	236	810	15.3.22
S 16/8	80	109	720	166	88	0,83	177	280	890	17.2.2
S 17/8	100	136	725	205	88	0,84	223	276	1100	21.2.17
S 18/8	125	170	725	255	88,5	0,84	228	340	1320	26.0.0
S 19/8	160	218	725	327	88,5	0,84	232	350	1500	29.2.3

Motors for 600 and 500 rpm. on request.

Available as foot motors according to design B 3 with short circuit and brush lifting device or with permanently sliding brushes. At regular working with constant torque the capacity of types has to be reduced for about 10% and 20% at a speed reduction of about 20% resp. 50%. For other figures inquiry is recommended.

Standard voltages of the motors 220, 380 and 500 volts, 50 c. p. s. In case of other voltages and frequencies please write for the corresponding dates.

Three-phase motor with slip ring rotor equipped with short circuit- and brush lifting device.

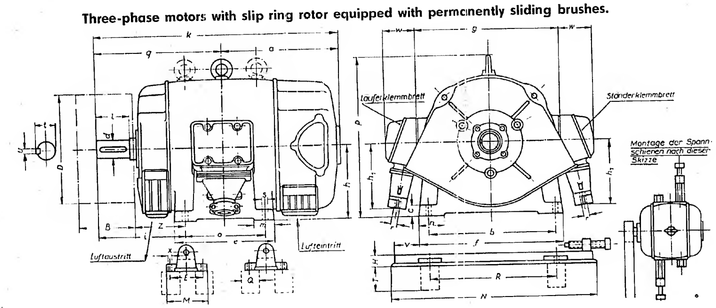


Luftaustritt = Air outlet Lufteintritt = Air inlet Montage der Spannschienen nach dieser Skizze = Mounting of the tension rails following this draft Läuferklemmbrett = Rotor terminal board Ständerklemmbrett = Stator terminal board Baugröße = Size of design Riemenscheibe = Pulley Spannschienen = Tension rails

Fit of the counter piece: H 7 Fit of the shaft stumps: m 6

Baugröße	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	w	h_1	Riemenscheibe B	Riemenscheibe D	Riemenscheibe Z	Spannschienen E	H	M	N	Q	R	T	V	X
12	255	500	50	65	355	600	570	335	375	1095	140	100	105	592,5	710	502,5	50	30	69	18	135	300	230	400	205	160	80	240	1000	80	590	500	200	M24
13	310	500	50	65	410	600	570	335	375	1150	140	100	105	620	710	530	50	30	69	18	135	300	230	450	205	160	80	240	1000	80	590	500	200	M24
14	300	600	60	75	400	700	665	375	424	1228	140	100	140	654	805	574	50	30	79,4	20	135	300	260	450	254	180	90	260	1170	80	650	500	200	M30
15	380	600	60	75	480	700	665	375	424	1308	140	100	140	694	805	614	50	30	79,4	20	135	300	260	500	254	180	90	260	1170	80	650	500	200	M30
16	360	670	60	80	465	770	740	400	460	1342	170	110	135	702	870	640	80	36	85,3	22	170	350												
17	425	670	60	85	530	770	740	400	460	1406	170	110	135	734	870	672	80	36	90,3	22	170	350												
18	410	740	70	90	530	860	810	450	475	1410	170	120	160	730	955	680	80	42	95,1	25	170	350												
19	490	740	70	95	600	860	810	450	475	1490	170	120	160	770	955	720	80	42	100,1	25	170	350												

Three-phase motors with slip ring rotor equipped with permanently sliding brushes.



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Fit of the shaft stumps: up to a diameter of 45 mm (abt. 1$^3/_4$") k6/H7, if more than a diameter of 45 mm: m6/H7.

Bauart	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	w	Riemenscheibe B	Riemenscheibe D	Riemenscheibe Z	Spannschienen E	H	M	N	Q	R	T	V	X
8	190	345	35	45	260	415	400	236	300	795	110	90	80	400	500	395	Pg29	25	48,3	14	100	140	250	175	120	55	180	700	80	400	400	160	M20
9	240	345	35	45	310	415	400	236	310	855	110	90	80	425	500	430	Pg29	25	48,3	14	100	170	320	170	120	55	180	700	80	400	400	160	M20
10	240	420	40	55	320	500	475	280	320	920	110	95	90	480	590	440	Pg29	25	58,6	16	100	200	320	180	150	72	200	825	80	490	400	200	M20
11	290	420	40	55	370	500	475	280	320	970	110	95	90	505	590	465	Pg29	25	58,6	16	100	200	360	180	150	72	200	825	80	490	400	200	M20

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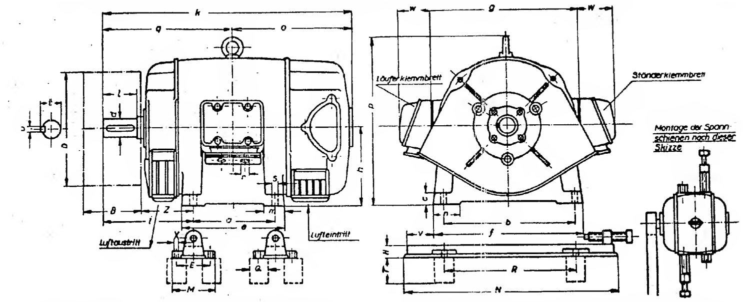
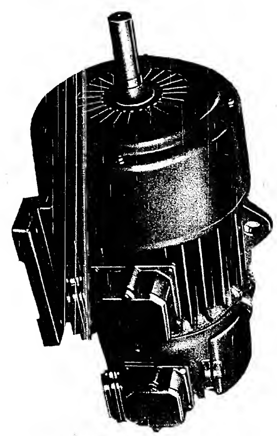
Three-phase motors with slip ring rotor equipped with permanently sliding brushes



Luftaustritt = Air outlet Lufteintritt = Air inlet Montage der Spannschienen nach dieser Skizze = Mounting of the tension rails following this draft Läuferklemmbrett = Rotor terminal board Ständerklemmbrett = Stator terminal board Baugröße = Size of design Riemenscheibe = Pulley Spannschienen = Tension rails
Fit of the counter piece: H 7 Fit of the shaft stumps: m 6

Baugröße	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	w	h_1	Riemenscheibe B	Riemenscheibe D	Riemenscheibe Z	Spannschienen E	Spannschienen H	Spannschienen M	Spannschienen N	Spannschienen Q	Spannschienen R	Spannschienen T	Spannschienen V	Spannschienen X
12	255	500	50	65	355	600	570	335	375	1006,5	140	100	105	504	710	502,5	50	30	69	18	135	300	230	400	205	160	80	240	1000	80	590	500	200	M24
13	310	500	50	65	410	600	570	335	375	1062	140	100	105	532	710	530	50	30	69	18	135	300	230	450	205	160	80	240	1000	80	590	500	200	M24
14	300	600	60	75	400	700	665	375	424	1138	140	100	140	564	805	574	50	30	79,4	20	135	300	260	450	254	180	90	260	1170	80	650	500	200	M30
15	380	600	60	75	480	700	665	375	424	1218	140	100	140	604	805	614	50	30	79,4	20	135	300	260	500	254	180	90	260	1170	80	650	500	200	M30
16	360	670	60	80	465	770	740	400	460	1240	170	110	135	600	870	640	80	36	85,3	22	170	350												
17	425	670	60	85	530	770	740	400	460	1302	170	110	135	630	870	672	80	36	90,3	22	170	350												
18	410	740	70	90	530	860	810	450	475	1330	170	120	160	650	955	680	80	42	95,1	25	170	350												
19	490	740	70	95	600	860	810	450	475	1410	170	120	160	690	955	720	80	42	100,1	25	170	350												



THREE-PHASE MOTORS
WITH SLIP RING ROTOR
jacket-cooling

Design B 3

Protective system P 33

Sanitized Copy Approved for Release 2010/08/18 : CIA-RDP81-01043R000400210006-4

Three-phase motors with slip ring rotor

Protective system P 33

Anti-friction beoring, design B 3, free shoft stump

Type	Capacity		Speed	Roted current ot 380 volts	Effi-ciency	Power foctor	Rotor dotes		Approx. weight	
	kW	HP	rpm.	amp.	%	cos φ	volts	omp.	kg	lbs.
No-lood speed 3000 rpm.										
S 22/2 M	2,2	3	2800	4,9	80	0,86	92	14,8	30	66
S 27/2 M	3	4	2810	6,4	82	0,87	131	14,1	36	79
S 32/2 M	4	5,5	2840	8,2	84	0,88	93	26,5	50	110
S 37/2 M	5,5	7,5	2850	11,3	84	0,88	127	26,8	60	132
S 42/2 M	7	9,5	2860	13,7	85	0,91	175	24,8	75	165
S 47/2 M	8,5	11,5	2880	16,6	85	0,91	203	25,9	95	209
S 52/2 M	12	16,5	2890	23	86	0,92	246	30,2	135	297
S 55/2 M	15	20	2900	28,9	86	0,92	292	32	155	342
No-lood speed 1500 rpm.										
S 22/4 M	1,6	2,2	1390	4	74	0,81	70	14,2	30	66
S 27/4 M	2,2	3	1390	5,4	76	0,81	90	15,1	36	79
S 32/4 M	3	4	1410	6,9	78	0,85	107	17,3	50	110
S 37/4 M	4	5,5	1415	8,9	81	0,84	140	17,6	60	132
S 42/4 M	5,5	7,5	1415	11,7	83	0,86	152	22,4	75	165
S 47/4 M	7,5	10	1415	16	83	0,85	190	24,4	95	209
S 52/4 M	9,2	12,5	1420	19	84	0,87	204	28	135	297
S 55/4 M	10	13,6	1425	22	87	0,87	256	26,6	155	342

Avoiloble as foot motors according to design B 3. Stondord voltoge of the motors 220, 380 or 500 volts, 50 c. p. s. In cose of other voltoges and frequencies please write for the corresponding dotes.

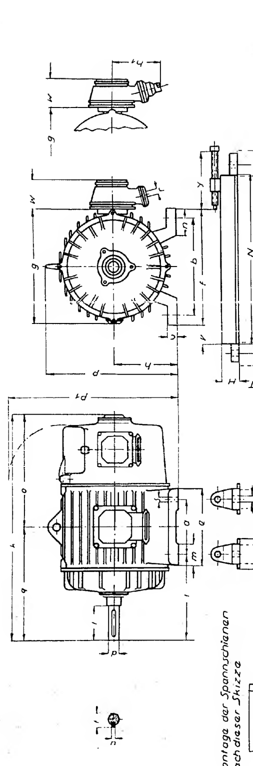
Three-phase motors with slip ring rotor

Protective system P 33

Anti-friction beoring, design B 3, free shoft stump

Type	Capocity		Speed	Rated current ot 380 volts	Effi-ciency	Power foctor	Rotor dotes		Approx. weight	
	kW	HP	rpm.	amp.	%	cos φ	volts	amp.	kg	lbs.
No-load speed 1000 rpm.										
S 22/6 M	0,8	1,1	920	2,5	67	0,72	60	8,3	30	66
S 27/6 M	1,1	1,5	920	3,2	71	0,73	77	8,84	36	79
S 32/6 M	1,6	2,2	920	4,2	73	0,74	63	14,9	50	110
S 37/6 M	2	2,7	920	5,5	75	0,74	83	14,9	60	132
S 42/6 M	3	4	930	7,5	77	0,79	128	16,9	75	165
S 47/6 M	4	5,5	930	9,8	78	0,79	145	15,8	95	209
S 52/6 M	5,5	7,5	930	12,1	85	0,81	176	19,4	135	297
S 55/6 M	7,5	10	935	12	86	0,82	212	23,2	155	342
No-load speed 750 rpm.										
S 22/8 M	0,4	0,55	680	1,7	60	0,60	31	8	30	66
S 27/8 M	0,6	0,82	680	2,1	66	0,67	40	9,1	36	79
S 32/8 M	1	1,36	690	3,2	69	0,68	51	12,1	50	110
S 37/8 M	1,3	1,8	690	4,2	72	0,70	64,5	13,4	60	132
S 42/8 M	1,8	2,5	700	5,1	76	0,70	92	12,3	75	165
S 47/8 M	2,2	3	700	6,3	74	0,72	104	13,1	95	209
S 52/8 M	4	5,5	705	10,3	81	0,73	146	17	135	297
S 55/8 M	5	6,8	705	12,7	81	0,74	170	18,2	155	342

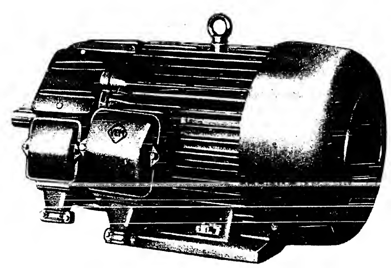
Avoiloble as foot motors according to design B 3. Standord voltoge of the motors 220, 380 or 500 volts, 50 c. p. s. In cose of other voltoges and frequencies please write for the corresponding dates.



Montage der Spannschienen nach dieser Skizze = Mounting of the tension rails following this draft Up to size 37 the motors are delivered without bearing eyes

Spannschiene = Tension rails

Typ	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	w	q_1	k_1	Spannschienen H	M	N	Q	R	T	V	X	Y
22 M	115	180	20	22	150	220	240	112	184	467	50	45	45	225	230	242	Pg 21	15	24,5	6	60			38	60	325	50	360	200	80	15	120
27 M	135	180	20	22	170	220	240	112	186	489	50	45	45	235	230	254	Pg 21	15	24,5	6	60	306	560	38	60	325	50	360	200	80	15	120
32 M	140	220	22	28	180	260	280	140	215	545	60	50	60	260	277	285	Pg 21	15	31	8	60			42	65	385	50	415	200	90	15	120
37 M	165	220	22	28	205	260	280	140	215	570	60	50	60	272	277	298	Pg 21	15	31	8	60			42	65	385	50	415	200	90	15	120
42 M	150	250	25	32	200	300	300	160	257	622	85	55	70	290	337	332	Pg 21	15	35,5	10	70			45	70	430	50	470	200	100	15	150
47 M	180	250	25	32	230	300	300	160	257	652	85	55	70	305	337	347	Pg 21	15	35,5	10	70			45	70	430	50	470	200	100	15	150
52 M	170	320	30	35	230	370	360	200	278	676	90	60	80	313	410	363	Pg 21	20	38,5	10	65			46	75	590	80	630	250	110	20	150
55 M	210	320	30	38	270	370	360	200	283	721	95	60	80	333	410	388	Pg 21	20	41,5	10	65			46	75	590	80	630	250	110	20	150



THREE-PHASE MOTORS WITH SLIP RING ROTOR

Design B 3

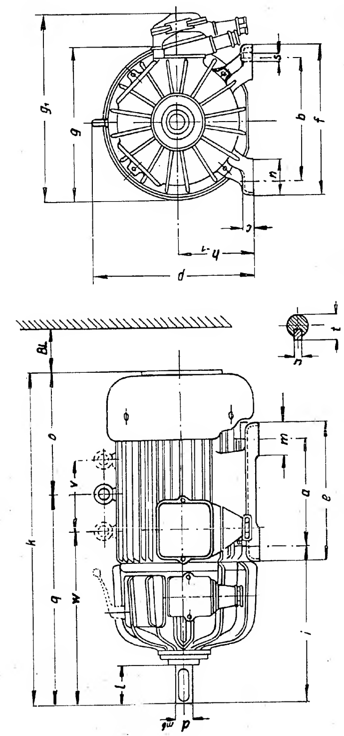
Protective system P 33

Three-phase motors with slip ring rotor

Protective system P 33, with surface-cooling by finned radiator

Anti-friction bearing, design B 3, free shaft stump

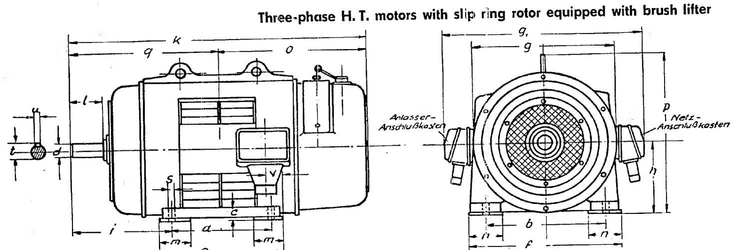
Type	Capacity		Rated speed	Rated current at 380 volts	Efficiency	Power factor	Rotor dates		Approx. weight	
	kW	HP	rpm.	amp.	%	cos φ	volts	amp.	kg	cwts.
No-load speed 1500 rpm.										
ASR 322/4	14	19,04	1460	27,3	88,5	0,88	226	39,5	245	4.3.8
ASR 325/4	20	27,2	1470	41,5	88,5	0,85	330	39	305	6.0.0
ASR 412/4	28	38,08	1470	53,5	90	0,88	200	88	460	9.0.6
ASR 416/4	38	51,68	1470	72	90	0,89	266	89	525	10.1.9
ASR 492/4	50	68	1475	93,5	91	0,89	266	113	710	13.3.25
ASR 496/4	63	85,68	1475	117	91	0,89	342	113	810	15.3.22
ASR 572/4	72	98	1480	129	91	0,93	236	187	1050	20.2.19
ASR 576/4	90	122	1480	160	92	0,93	306	178	1180	23.0.0
ASR 652/4	112	152	1485	200	94	0,9	362	183	1420	28.0.0
ASR 656/4	144	196	1485	255	94	0,91	435	195	1590	31.0.0
ASR 732/4	180	245	1485	333	92	0,89	425	258	2100	41.0.0
ASR 736/4	225	306	1485	417	92	0,89	567	240	2300	45.0.0



Type	a	b	c	d	e	f	g	g_1	h	i	k	l	m	n	o	p	q	s	t	u	v	w	Bl
ASR and ABR 572	460	630	60	75	580	740	765	883	375	569	1384	140	140	175	585	844	799	33	79,6	20			70
ASR and ABR 576	520	630	60	75	640	740	765	883	375	569	1444	140	140	175	615	844	829	33	79,6	20			70
ASR and ABR 652	530	720	70	85	660	840	860	997	425	660	1548	170	155	200	623	970	925	33	90,5	22			
ASR and ABR 656	590	720	70	85	720	840	860	997	425	660	1608	170	155	200	653	970	955	33	90,5	22			
ASR and ABR 732	550	810	80	90	690	950	984	1050	475	705	1650	170	170	225	670	1071	980	39	95,3	25	400	721	
ASR and ABR 736	660	810	80	95	800	950	984	1050	475	705	1760	170	170	225	725	1071	1035	39	110,3	25	500	726	

ASR without brush lifter — ABR with brush lifter

Three-phase H. T. motors with slip ring rotor equipped with brush lifter



Anlasser-Anschlußkasten = Starter junction box
Netz-Anschlußkasten = Mains junction box
Shaft stump m_6; Bore of the coupling H 7
Measures in mm without engagement
Größe = Size

Größe	a	b	c	d	e	f	g_1	g	h	i	k	l	m	n	o	p	q	s	t	u	v
981— 4	750	1000	102	130	1080	1270	1690	1220	630	780	2362	250	270	270	1207	1395	1155	50	136,8	32	237
981— 6	750	1000	102	130	1080	1270	1690	1220	630	780	2362	250	270	270	1207	1395	1155	50	136,8	32	237
981— 8	750	1000	102	130	1080	1270	1690	1220	630	780	2362	250	270	270	1207	1395	1155	50	136,8	32	237
981—10	670	1000	102	130	1000	1270	1690	1220	630	780	2282	250	270	270	1167	1395	1115	50	136,8	32	237
981—12	670	1000	102	130	1000	1270	1690	1220	630	780	2282	250	270	270	1167	1395	1115	50	136,8	32	237
983— 4	850	1000	102	130	1180	1270	1690	1220	630	780	2462	250	270	270	1257	1395	1205	50	136,8	32	237
983— 6	850	1000	102	130	1180	1270	1690	1220	630	780	2462	250	270	270	1257	1395	1205	50	136,8	32	237
983— 8	850	1000	102	130	1180	1270	1690	1220	630	780	2462	250	270	270	1257	1395	1205	50	136,8	32	237
983—10	750	1000	102	130	1080	1270	1690	1220	630	780	2362	250	270	270	1207	1395	1155	50	136,8	32	237
983—12	750	1000	102	130	1080	1270	1690	1220	630	780	2362	250	270	270	1207	1395	1155	50	136,8	32	237
985— 4	950	1000	102	130	1280	1270	1690	1220	630	780	2562	250	270	270	1307	1395	1255	50	136,8	32	237
985— 6	950	1000	102	130	1280	1270	1690	1220	630	780	2562	250	270	270	1307	1395	1255	50	136,8	32	237
985— 8	950	1000	102	130	1280	1270	1690	1220	630	780	2562	250	270	270	1307	1395	1255	50	136,8	32	237
985—10	850	1000	102	130	1180	1270	1690	1220	630	780	2462	250	270	270	1257	1395	1205	50	136,8	32	237
985—12	850	1000	102	130	1180	1270	1690	1220	630	780	2462	250	270	270	1257	1395	1205	50	136,8	32	237

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Three-phase motors with slip ring rotor

Protective system P 11

Anti-friction bearing, design B 3, free shaft stump

Type	Capacity		Rotor		Roted speed	Approx. weight	
	kw	abt. HP	volt	amp.	rpm.	kg	cwts.
No-load speed 600 rpm.							
DSE 653–10	120	165			575	1650	32
,, 755–10	145	195			575	1830	36
,, 731–10	175	240	380	280	580	2040	40
,, 733–10	210	285	450	280	550	2270	45
,, 735–10	250	340	560	270	580	2500	49
,, 841–10	300	410	530	350	585	2830	56
,, 843–10	360	490	640	345	585	3130	61
No-load speed 500 rpm							
DSE 653–12	95	130			475	1650	32
,, 655–12	110	150			475	1830	36
,, 731–12	135	185			480	2040	40
,, 733–12	160	220			480	2270	45
,, 735–12	190	260			480	2500	49
,, 841–12	220	300			485	2830	56
,, 843–12	280	380			485	3130	61
,, 845–12	310	420			485	3700	73

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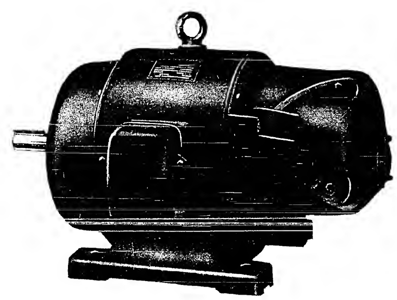

Sachsenwerk Radeberg - THREE-PHASE CRANE MOTORS WITH SLIP RING INDUCTION ROTOR

Style of enclosure P 22, splash-proof.

P 33, enclosed

Design B 3

Three-phase crane motors with slip ring induction rotor
without brush-lifter, ball bearings with grease lubrication.

Style of enclosure P 22 splash proof
for permanent working and interrupted working (for cranes) with a total time of 25% and 40%.

Style of enclosure P 33 enclosed
for crane working only.

For standard voltages of 220/380 volts and 500 volts at 50 c.p.s. speed (last motion) 1500 and 1000 rpm. If possible, avoid to order crane motors with 1500 rpm because of their limited use, and of their longer time of delivery.

2- to 2.5-fold starting torque at . . . -fold startig current.

Design B 3 only
with regular free shaft end, with 2nd shaft end only deliverable for orders of importance.

Stator and rotor winding:
Copper wire with varnish-silk-insulation.
Crane motors are **not** allowed for permanent working.

Ranges of capacity:

splash-proof:		enclosed:
permanent working:	crane working:	crane working only:
4 –11 kW	4 –11,5 kW	2,4–8,5 kW at 1500 rpm
2,5– 7 kW	2,5– 8,5 kW	1,7–6 kW at 1000 rpm

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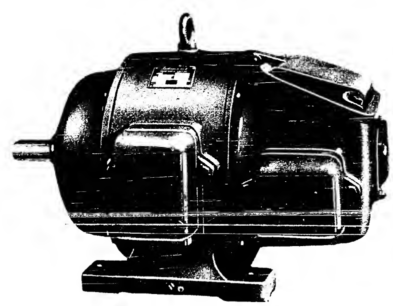

Sachsenwerk Niedersedlitz **-THREE-PHASE CRANE MOTORS**
with control slip ring induction rotor

Style of enclosure: P 33

Design B 3

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Three-phase crane motors with control slip ring induction rotor

Style of enclosure P 33 Terminal covering P 22

Anti-friction bearings Design B 3, free shaft stump

Type	Capacity kW	Speed rpm	Stator current at 380 volts A	Rotor about V	Rotor about A	Maximum speed rpm	Moment of inertia GD^2 kgm^2	Weight about kg	Weight about Cwts.
Lost motion speed 1000 rpm 25% ED Tilting moment 2,6-fold									
ODKn 55–6	4,2	920	10,6	139	28	2500	0,5	110	2.1.0
ODKn 56–6	6	930	14,6	104	29	2500	0,6	130	2.3.0
ODKn 65–6	8,5	940	21	225	25	2300	1,7	180	3.2.0
ODKn 66–6	11,5	950	26	290	25	2300	2	210	4.0.0
ODKn 67–6	15	955	35	395	25	2300	2,4	250	5.0.0
ODKn 75–6	21	950	47	175	80	2100	3	370	7.1.0
ODKn 76–6	27	955	56	215	80	2100	3,5	400	8.0.0
ODKn 85–6	35	960	70	245	90	1900	5,4	520	10.1.0
ODKn 86–6	45	960	90	295	97	1900	6,4	570	11.1.0
ODKn 95–6	62	965	129	235	170	1800	12,5	750	15.0.0
ODKn 96–6	78	965	162	290	170	1800	14,5	820	16.0.0
Lost motion speed 1000 rpm 40% ED Tilting moment 3,2-fold									
ODKn 55–6	3	940	8,5	104	19	2500	0,5	110	2.1.0
ODKn 56–6	4,2	945	11,5	139	20	2500	0,6	130	2.3.0
ODKn 65–6	6,5	950	18,5	225	19,5	2300	1,7	180	3.2.0
ODKn 66–6	8,5	955	24	290	19	2300	2	210	4.0.0
ODKn 67–6	11	960	30	395	17,5	2300	2,4	250	5.0.0
ODKn 75–6	15,5	955	36	175	58	2100	3	370	7.1.0
ODKn 76–6	20	960	45	215	60	2100	3,5	400	8.0.0
ODKn 85–6	25	965	55	245	66	1900	5,4	520	10.1.0
ODKn 86–6	32	965	69	295	69	1900	6,4	570	11.1.0
ODKn 95–6	45	970	95	235	124	1800	12,5	750	15.0.0
ODKn 96–6	56	970	119	290	124	1800	14,5	820	16.0.0

Three-phase crane motors with control slip ring induction rotor

Style of enclosure P 33 Terminal covering P 22

Anti-friction bearings Design B 3, free shaft stump

Type	Capacity kW	Speed rpm	Stator current at 380 volts A	Rotor about V	Rotor about A	Maximum speed rpm	Moment of inertia GD^2 kgm^2	Weight about kg	Weight about Cwts.
Lost motion speed 750 rpm 25% ED Tilting moment 2,6-fold									
ODKn 65–8	6,5	705	17	140	31	2200	1,9	180	3.2.0
ODKn 66–8	8,5	710	21	190	31	2200	2,2	210	4.0.0
ODKn 67–8	12	710	28	255	31	2200	2,7	250	5.0.0
ODKn 75–8	16	700	36,5	170	62	2000	3,3	370	7.1.0
ODKn 76–8	20	705	44,5	208	64	2000	4	400	8.0.0
ODKn 85–8	28	715	61	244	75	1800	6	520	10.1.0
ODKn 86–8	35	715	74	290	76	1800	7,4	570	11.1.0
ODKn 95–8	50	725	107	215	148	1700	13,6	750	15.0.0
ODKn 96–8	64	725	128	260	153	1700	16,3	820	16.0.0
Lost motion speed 750 rpm 40% ED Tilting moment 3,2-fold									
ODKn 65–8	4,8	710	13,5	140	23	2200	1,9	180	3.2.0
ODKn 66–8	6,4	715	18	190	23	2200	2,2	210	4.0.0
ODKn 67–8	9	715	24	255	23	2200	2,7	250	5.0.0
ODKn 75–8	11,5	710	29	170	43	2000	3,3	370	7.1.0
ODKn 76–8	14,5	715	36	208	45	2000	4	400	8.4.0
ODKn 85–8	20	720	49	244	54	1800	6	520	10.1.0
ODKn 86–8	25	720	59	290	54	1800	7,4	570	11.1.0
ODKn 95–8	35	730	84	215	105	1700	13,6	750	15.0.0
ODKn 96–8	45	730	100	260	105	1700	16,3	820	16.0.0

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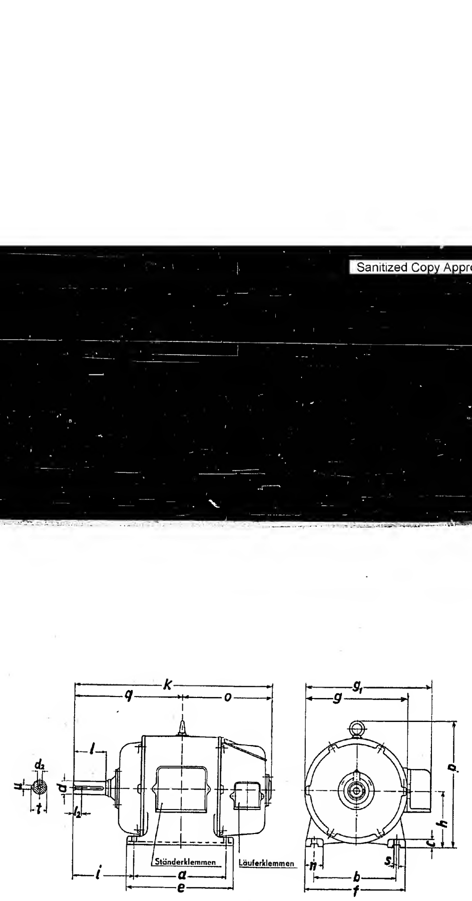

Size	a	b	c	e	f	g	g_1	h*)	i	k	n	o	p	q	s ∅
55	260	270	32	315	345	358	432	190	215	680	75	335	435	345	18
56	300	270	32	355	345	358	432	190	215	720	75	355	435	365	18
65	275	325	35	335	410	426	496	225	278,5	775	85	359	512	416	23
66	320	325	35	380	410	426	496	225	278	819	85	381	512	438	23
67	390	335	35	450	410	426	496	225	278	889	85	416	512	473	23
75	370	385	38	440	480	488	595	260	305	935	95	445	585	490	23
76	430	385	38	500	480	488	595	260	315	1005	95	475	585	530	23
85	440	435	40	520	540	552	660	280	350	1065	105	495	650	570	27
86	500	435	40	580	540	552	660	280	360	1135	105	525	650	610	27
95	500	510	50	590	620	640	787	340	360	1137	110	527	760	610	27
96	570	510	50	660	620	640	787	340	380	1227	110	562	760	655	27

	Shaft stump					
Size	d∅**)	l	u	t	d_2	l_2
55	38	80	10	41,5	M 12	38
56	38	80	10	41,5	M 12	38
65	45	110	14	48,5	M 16	45
66	45	110	14	48,5	M 16	45
67	55	110	16	58,8	M 20	53
75	55	130	16	58,8	M 20	53
76	60	140	18	64,2	M 20	53
85	65	160	18	69,2	M 20	53
86	70	170	20	74,6	M 20	53
95	75	180	20	79,6	M 20	53
96	80	200	22	85,5	M 20	53

*) Admissible deviation
up to size 67 : 0,5 mm (= abt. $^1/_{64}$″),
from size 75 : 1 mm (= abt. $^3/_{64}$″)

**) Fits:
up to 45 ∅ ISA k 6,
more than 45 ∅ ISA m 6

Measures in mm

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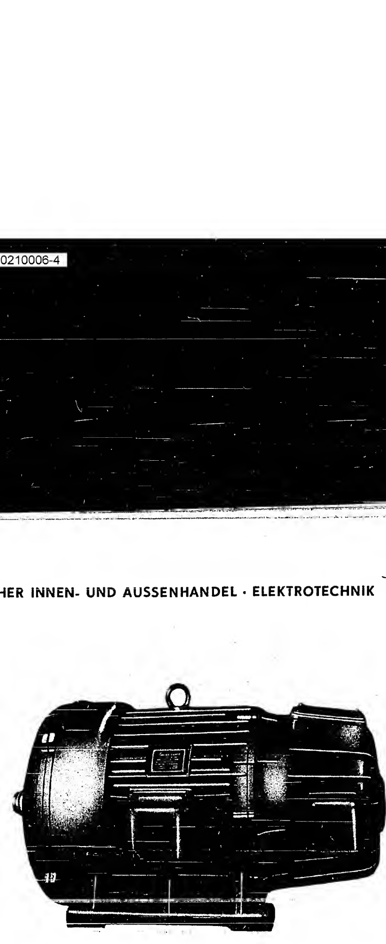


Sachsenwerk Niedersedlitz

ENCLOSED THREE-PHASE CURRENT MOTORS

for interrupted working

Frequent repetition switching, with control slip ring induction rotor

Style of enclosure P 33 with surface airing

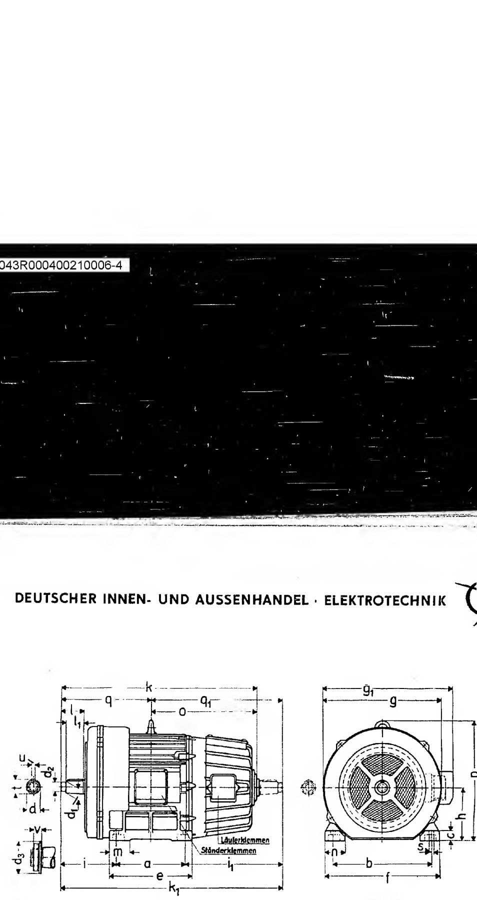
Design B 3

Enclosed three-phase current motors for interrupted working

Frequent repetition switching, with control slip ring induction rotor
Style of enclosure P 33, with surface airing, terminal covering (P 22), asbestos insulation. Anti-friction bearing with labyrinth packings, design B 3, free shaft stump, for direct coupling only.

Type	% ED	Capacity*) kW	Speed rpm	Stator current at 380 volts about A	Rotor dates Tension abt V	Rotor dates Current abt. A	Mk/Mn	Moment of inertia GD² kgm²	Weight net about kg	Weight net about Cwts.
DOR 106- 8	25	125	725	254	310	254	2	44	1510	30.0.0
	40	100	730	210		200	2,5			
	60	80	735	177		160	3,1			
DOR 107- 8	25	160	730	325	400	252	2	52	1710	34.0.0
	40	125	735	263		195	2,5			
	60	100	735	225		157	3,2			
DOR 108- 8	25	200	730	400	495	252	2,1	60	1910	38.0.0
	40	160	735	332		200	2,6			
	60	125	735	277		155	3,3			
DOR 116- 8	25	250	735	464	487	315	2,2	110	2480	48.0.0
	40	200	735	377		252	2,8			
	60	160	740	312		200	3,5			
DOR 117- 8	25	320	735	589	605	320	2,2	129	2800	55.0.0
	40	250	740	464		243	2,8			
	60	200	740	386		200	3,5			
DOR 106-10	25	100	580	219	250	253	2,1	44	1510	30.0.0
	40	80	585	183		200	2,6			
	60	63	585	157		157	3,3			
DOR 107-10	25	125	580	266	313	254	2,1	52	1710	34.0.0
	40	100	585	222		200	2,6			
	60	80	585	191		160	3,3			
DOR 108-10	25	160	580	332	380	264	2,1	60	1910	38.0.0
	40	125	585	272		204	2,7			
	60	100	585	234		163	3,4			
DOR 116-10	25	200	585	400	408	302	2,2	110	2480	48.0.0
	40	160	590	331		233	2,8			
	60	125	590	274		190	3,5			
DOR 117-10	25	250	585	490	505	303	2,2	129	2800	55.0.0
	40	200	590	405		239	2,8			
	60	160	590	338		194	3,5			
DOR 118-10	25	320	585	624	635	310	2,2	153	3200	63.0.0
	40	250	590	505		240	2,8			
	60	200	590	425		195	3,5			

*) The capacity is about 50% of the capacity at 25% ED when permanent working is required.



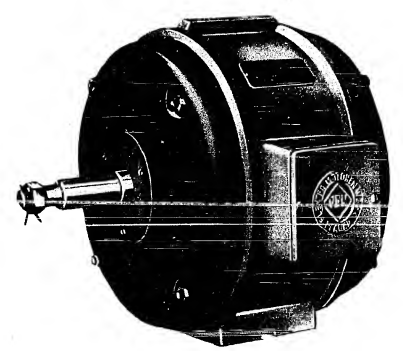
Size	a	b	c	e	f	g	g_1	h*)	i	i_1	k	k_1	m	n
106	520	675	85	620	820	820	895	400	440	740	1470	1700	180	145
107	620	675	85	720	820	820	895	400	440	740	1570	1800	180	145
108	720	675	85	820	820	820	895	400	440	740	1670	1900	180	145
116	590	860	85	710	1000	1030	1128	450	480	810	1648	1880	180	170
117	680	860	85	800	1000	1030	1128	450	480	810	1738	1970	180	170
118	800	860	85	920	1000	1030	1128	450	480	810	1858	2090	180	170

Size						Shaft ends								
	a	p	q	q_1	s∅	d	d_d 1	d 2	l	l_1	t	u	d3∅	v
106	770	855	700	1000	33	100	83,5	M 76 × 2	210	165	104	28	135	33,5
107	820	855	750	1050	33	100	83,5	M 76 × 2	210	165	104	28	135	33,5
108	870	855	800	1100	33	100	83,5	M 76 × 2	210	165	104	28	135	33,5
116	873	1042	775	1105	40	120	103,5	M 80 × 2	210	165	124,5	32	140	35,5
117	918	1042	820	1150	40	120	103,5	M 80 × 2	210	165	124,5	32	140	35,5
118	978	1042	820	1210	40	120	103,5	M 80 × 2	210	165	124,5	32	140	35,5

Conical shaft ends according to DIN 749 — Measures in mm

Construction with 2 shaft stumps on special order!

*) Admissible deviation for measure h = minus 1 mm



VEM THREE-PHASE LOOM-MOTORS

The loom-motor type DW is a totally enclosed three-phase motor with a double squirrel-cage rotor, style of enclosure P 33. Its construction — as regards electrical and mechanical details — is completely adapted to the operating conditions of weaving mills. The totally enclosed construction, the absence of an external fan as well as the even exterior, by which the settling-down of fibredust is avoided, and the bedding on antifriction bearings guarantee a high reliability in service.

The motor is available:

a) as motor for plain surfaces B 5

b) as motor with piedestal — design B 3 with screwed footing.

Output, Voltage, Speed

All figures given in this list are nominal outpouts for permanent service. Motors for the following voltages are available:

125/220 V, 220/380 V, 290/500 V, 380/660 V, 500/860 V

These motors can be connected either in star-or delta-connection.

To meet the demonds af textile-mills, these motors are built with six-polar winding, i. e. far 950 rpm. This speed is reached at the naminal autpout and mains frequency of 50 c.p.s.

Starting Torque and Storting Current

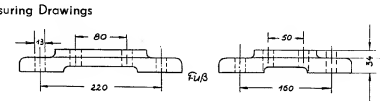
To decide about the pawer of a loam-motor, twa paints have ta be taken into conside-ration: It is the autpaut during the normal running of the laom, and especially the mean storting torque, the motor has ta develop, in arder to speed up the loom fram standstill to the full number of turns. The starting torque af the matars in the list is at least 2,5 times the narmal torque. The starting current amounts ta about the 4–6-fold af the nominal current.

Shaft-End, Bearings, Lubrication

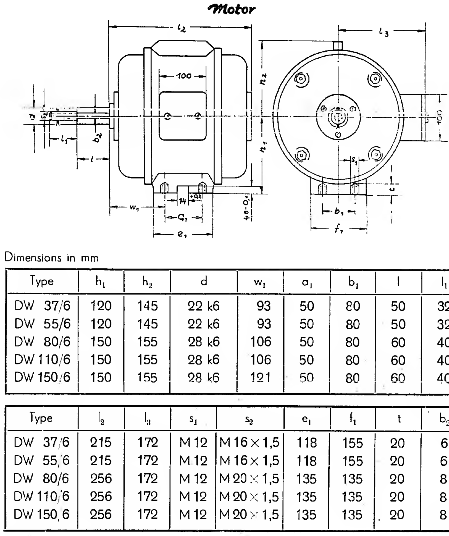
The shaft-ends of the motors are provided – accarding ta German Boord of Standards – with ISA seating k 6. Belt pulleys or pinians must have a drill-hole H 7 (German Board of Standards).
All motars are equipped with ontifrictian bearings: on the driving end with raller bearings, NL 35 or NL 25, on the blind end with ball bearings 6206 or 6205.
For lubrication ball bearing-grease of best quality is used.
It was purposely omitted to place lubricators far re-lubricatian of the bearings. You run a risk only to press fresh grease in the bearing, while the used up greose is not removed. Besides, by lock of control, the surplus greose rushes out af the bearing, thus soilling the winding and other parts of the motor. One lubrication of the bearings is sufficient for 3000 running hours. In order to have the guarantee af a proper working, it is advisable to open the motor in adequate intervals, to remave entirely the ald grease of the bearings by woshing them out and to lubricate them with fresh grease. For lubricatian, vaseline, Stauffer grease, ond ail must by na means be used.

Type	Copacity		Nomi-nal speed	Naminal current at 380 V	Effi-ciency	Copacity factor	Weight abaut design			
							a		b	
	kW	HP	rpm	A	%	cos φ	kg	lbs.	kg	lbs.
DW 37/6	0,37	0,47	950	0,95	8	0,74	28	62	33	73
DW 55/6	0,55	0,75	950	1,36	82	0,75	34	75	39	85
DW 80/6	0,8	1,09	950	1,9	84	0,77	43	94	48	105
DW 110/6	1,1	1,5	950	2,5	85	0,8	57	125	62	136
DW 150/6	1,5	2,04	950	3,3	86	0,82	65	143	70	154

Measuring Drawings



Motor



Dimensions in mm

Type	h_1	h_2	d	w_1	a_1	b_1	l	l_1
DW 37/6	120	145	22 k6	93	50	80	50	32
DW 55/6	120	145	22 k6	93	50	80	50	32
DW 80/6	150	155	28 k6	106	50	80	60	40
DW 110/6	150	155	28 k6	106	50	80	60	40
DW 150/6	150	155	28 k6	121	50	80	60	40

Type	l_2	l_3	s_1	s_2	e_1	f_1	t	b_2
DW 37/6	215	172	M 12	M 16 × 1,5	118	155	20	6
DW 55/6	215	172	M 12	M 16 × 1,5	118	155	20	6
DW 80/6	256	172	M 12	M 20 × 1,5	135	135	20	8
DW 110/6	256	172	M 12	M 20 × 1,5	135	135	20	8
DW 150/6	256	172	M 12	M 20 × 1,5	135	135	20	8

Cotter according to DIN 94 4 mm ∅ (abt. 5/32″)
Castel nut according to DIN 935 (German Board of Standards)

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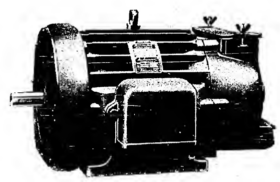
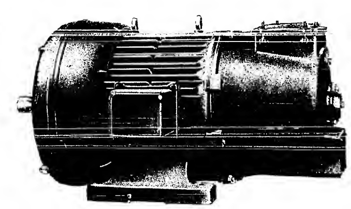
DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



Type HDRO 66 and 77 with finned radiator



Type HDRO 95 ... 108 with finned tubular radiator

Sachsenwerk Niedersedlitz - **THREE-PHASE CURRENT MOTORS FOR IRON WORKS**

for heavy operation

Frequent repetition switching, with control slip ring induction rotor

Style of enclosure P 33, with surface airing

Design B 3

Three-phase current motors for iron works for heavy operation

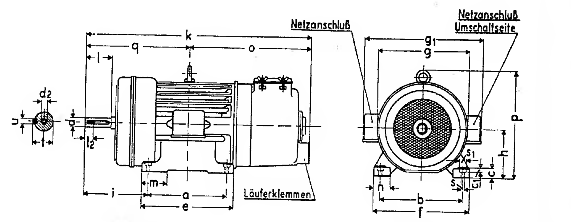
Frequent repetition switching, with control slip ring induction rotor

Style of enclosure: P 33, with surface oiring, with two boards for stator terminals (P 21), asbestos insulation

Anti-friction bearing with labyrinth packings, design B 3, free shaft stump

Type	Capacity *)	Speed	Stator current at 380 volts	Rotor about		Moment of inertia GD^2	Weight about	
	kW	rpm	A	V	A	kgm^2	kg	Ctws.
40/25 % ED-tilting moment 2,8/2,3-fold								
HDRO 66–6	9/11	950	21/24	205	28/34	2,7	300	6.0.0
HDRO 77–8	18/22	715	48/54	130	87/107	5	530	10.2.0
HDRO 95–10	32/38	575	78/93	140	144/176	17	950	18.2.0
HDRO 96–10	42/50	580	99/112	180	146/174	20	1030	20.0.0
HDRO 106–10	66/80	585	153/175	258	154/187	42	1600	31.2.0
HDRO 108–10	100/125	585	226/268	335	182/228	60	2000	39.0.0

*) The motors have a reserve of heating of about 30 %. If the starting takes place against the nominal moment and the external GD^2 corresponds to the rotor GD^2, 120 switching, hourly are admissible without any decrease of the capacity.



Netzanschluß = mains connection; Netzanschluß, Umschaltseite = mains connection, change-over side; Lauferklemmen = running clamps

Size	a	b	c	c_1	e	f	g	g_1	h_1	i	k	m	n	o	p	q
66– 6	310	320	35	15	360	400	450	605	190	240	840	110	70	445	460	395
77– 8	440	360	45	20	520	460	520	640	235	305	1145	130	90	620	565	525
95–10	520	550	75	35	640	670	710	940	340	430	1475	180	140	785	740	690
96–10	590	550	75	35	710	670	710	940	340	430	1545	180	140	820	740	725
106–10	520	700	85	–	610	820	865	1060	425	555	1705	220	150	890	875	815
108–10	720	700	85	–	810	820	865	1060	425	555	1905	220	150	990	875	915

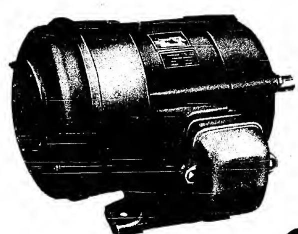
Size			Shaft stump					
	s ∅	s_1 ∅	d ∅ **)	l	t	u	d_2	l_2
66– 6	18	22	45	110	48,5	14	M 16	45
77– 8	22	30	65	140	69,2	18	M 20	53
95–10	28	34	80	170	85,5	22	M 20	53
96–10	28	34	80	170	85,5	22	M 20	53
106–10	28	–	100	210	106,1	28	M 24	63
108–10	28	–	100	210	106,6	28	M 24	63

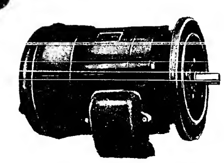
*) Admissible deviation for measure h:
up to 235 mm = min 0,5 mm (about 1/64")
more than 235 mm = min 1 mm (about 3/64")

**) Fit: up to 45 ∅ ISA k 6,
more than 45 ∅ ISA m 6

Measures in mm

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK





Sachsenwerk Radeberg

THREE-PHASE CURRENT MOTORS WITH SQUIRREL-CAGE ROTOR

Designs: B 3 and B 5

Style of enclosure: P 330 "increased safety"

for explosion- and firedamp-proof service

Technical dates:

The Three-phase current motors answer the "Rules for Electric Engines REM", according to DIN 57530:

Three-phase current motors with squirrel-cage rotors, ball bearing with grease lubrication
Style of enclosure P 330 encased, surface cooling, design "increased safety" according to DIN 57170/171
Ignition group A and B

Voltages: 220/380 volts, 500 volts at 50 c. p. s.

Speed: (last motion): 3000, 1500, 1000 rpm

Starting torque: 2 to 2,5-fold starting torque at direct switching and at 5 to 6,4-fold starting current

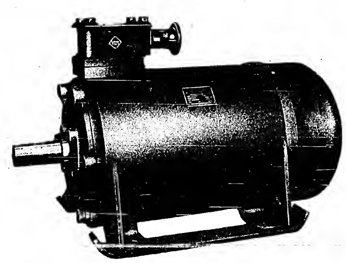
Designs B 3 and B 5 can be used in any position, even vertically, however without any additional axial load. With normal free shaft end, designs with a 2nd shaft end only deliverable for more substantial orders

Stator winding: Copper wire with varnish insulation, larger motors with varnish silk insulation

Rotor: These motors in the special design "increased safety" are, on the basis of certificates of the trial track Freiberg (Saxonia), admitted for rooms endangered by explosive gases and air mixtures of the ignition group A and B, and for firedamp-endangered mines, if the necessary switching implements are used. The motors are not allowed for locally prescribed service instruments, such as drilling machines or launder coolers in firedamp-endangered mines.

Power ranges: 1,5 to 8 kW at 3000 rpm
1,1 to 8 kW at 1500 rpm
0,6 to 5 kW at 1000 rpm

These figures are valid for the explosion-proof motors. If the firedamp-proof design is chosen, the capacity of all the types will be up to max. 10 % lower.



VEM THREE-PHASE DOUBLE GROOVE SQUIRREL-CAGE INDUCTION MOTORS

in compression proof encasing, firedamp-proof

according to DIN (German Board of Standards) 57170

Style of enclosure P 33, with antifriction bearings,
with piedestal and a free shaft stump according to DIN design B 3

Available for the standard voltages of 220, 380 or 500 volts, 50 c.p.s.

Type	Capacity		Nominal speed	Nominal current at 380 volts	Efficiency	Capacity factor	Weight about	
	kW	HP	about rpm	about A	%	cos φ	kg	Cwts.
D 8/4 d (Sch)	14	19	1465	29	87	0,85	220	4.2.0
D 9/4 d (Sch)	20	27	1470	40	90	0,85	270	5.2.0
D 10/4 d (Sch)	28	38	1475	56	90	0,85	350	7.0.0
D 11/4 d (Sch)	38	52	1480	74	91	0,86	510	10.0.0
D 12/4 d (Sch)	50	68	1480	96	91,5	0,87	645	12.3.0
D 13/4 d (Sch)	63	86	1480	120	92	0,87	800	16.0.0

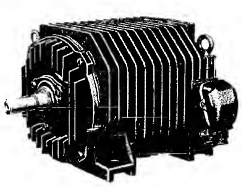
The motor is delivered with cable-entrance in the shaft's direction. If required, the terminal box can be transposed in your factory, as marked by dots and dashes in the drawing.

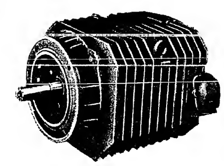
Size of design	a	b	d	f	g	h	i	k	l	n	p	q	s	t	u	y	z
8	235	380	55	450	374	200	210	750	110	80	500	231	23	58,6	16	185	105
9	320	380	55	450	374	200	210	835	110	80	500	231	23	58,6	16	185	105
10	435	380	55	450	374	200	210	950	110	80	500	231	23	58,6	16	185	105
11	330	450	65	520	525	280	270	915	140	80	660	280	23	69	18	185	168
12	435	450	65	520	525	280	270	1020	140	80	660	280	23	69	18	185	168
13	555	450	65	520	525	280	270	1140	140	80	660	280	23	69	18	185	168

Fits of the shaft stumps: up to 45 mm (about $1^3/_4''$) Ø k 6

more than 45 mm (about $1^3/_4''$) Ø m 6

Fits of the counter-piece: H 7





Sachsenwerk Radeberg

ROLLER GEAR BED MOTORS FOR THREE-PHASE CURRENT

Style of enclosure P 33, surface cooling

Designs: B 3 and B 5

Specially designed for rough working in rolling mills

The **roller gear bed motors** have been designed for the drive of all the rolls before and behind the roller frames and the cutters of the rolling trains in steel plants. They are, furthermore, used for the drive of the transport roller gear beds transporting the material to the working roller gear beds.

The heat-proof winding of the stator replies to the high demands of the working in the roller mill, such as the frequent change of direction, a high starting torque, a fixed brake of the motor to absolute stop within 2 minutes time, when the current is on. Seeing that these motors have a large surface by the many radial and cooling ribs, the heat is carried away without special air cooling.

The constancy of acceleration is a characteristic for the roller gear bed motors. It is measured in kilos M 2/h, and represents the sum of the total flywheel effect (roll or body + armature) and the number of switchings per hour. When making out this number of switchings, the starting switchings and the opposed current brakings should be separated.

Enquiries should contain the following dates: Flywheel effect of the bodies, their number of revolutions, the gear ratio of the perhaps intended working or drive, switching-frequency per hour, whether change of turning direction, or without opposed current braking, ED in percents, and indication whether design B 3 or B 5 is wanted.

In designing the motors with an entirely closed, dust- and water-proof encasing, and in giving them their strong mechanical construction, the rough working conditions in the rolling mills have been considered.

Technical dates:

The Three-phase current motors answer the "Rules for Electric Engines REM", according to DIN 57530:

Three-phase current motors with squirrel-cage rotors, ball bearing with grease lubrication
Style of enclosure P 35 (encosed, surface cooling)

Speed (lost motion): 750, 600 rpm. See the following table.
2,3 to 2,5-fold starting torque and 3,5 to 4-fold starting current.

Voltages: 220, 380 volts, 500 volts at 50 c. p. s.

Stator winding: Copper wire, insulation class B (heat-proof winding).

Rotor: Squirrel-cage rotor with aluminium die casting.

For the present, the following types are available:

ARA 33 – 8	0,8 kW	700 rpm	100% constancy of acceleration	1380
ARA 54 – 10	2,0 kW	570 rpm	100% constancy of acceleration	4800
ARA 54 – 8	3,0 kW	700 rpm	100% constancy of acceleration	3000
ARA 65 – 10	4,5 kW	515 rpm	40% ED	6000

TABLE OF CONTENTS

SINGLE-PHASE AND UNIVERSAL MOTORS Group 2

Single-Phase Induction Motors . . . . . a

Single-Phase Repulsion Motors . . . . . b

Universal Motors c

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Small-sized Motors . . . . . d 1

Sewing Machine Motors . . . . . d 2

Tube Installation Motors . . . . . d 3

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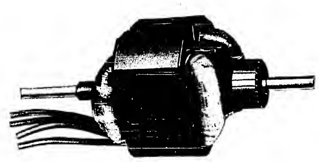


IKA REPULSION INSTALLATION MOTOR

TYPE FREIA

for 110/220 V A.C. Frequency 50 c.p.s.

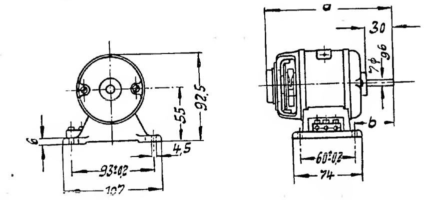
Application: Special driving motor for portable sewing machine Freia

Type	Capacity W	Speed rpm.	Weight about kg	Weight about lbs.
Freia	25	0–3000 variable	1,6	$3^1/_2$

VEM Encased Motors Type PM 70

Ball Bearings for AC DC

Design with brush bridge

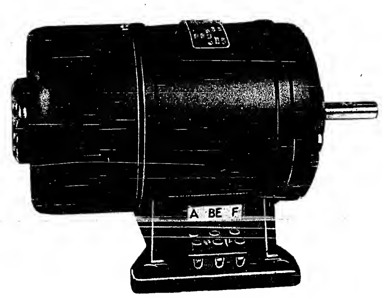


Type	o	b
PM 70–30	136,5	45
PM 70–40	146,5	50

No. for orders 110 V	No. for orders 220 V	Type	Speed rpm.	Capacity W	Wattage W	Torque cm g	Weight abt. kg	Weight abt. lbs.
PK 732 N	PK 732 R	PM 70–30	2000	8	35	390	1,1	$2^7/_{16}$
PK 733 N	PK 733 R		3000	12	40	388		
PK 734 N	PK 734 R		4000	17	50	413		
PK 735 N	PK 735 R		5000	23	65	450		
PK 736 N	PK 736 R		6000	30	80	486		
PK 738 N	PK 738 R		8000	40	85	486		
PK 7310 N	PK 7310 R		10000	50	105	487		
PK 742 N	PK 742 R	PM 70–40	2000	11	40	535	1,3	$2^7/_8$
PK 743 N	PK 743 R		3000	15	45	485		
PK 744 N	PK 744 R		4000	20	55	486		
PK 745 N	PK 745 R		5000	26	70	504		
PK 746 N	PK 746 R		6000	35	85	567		
PK 748 N	PK 748 R		8000	45	100	547		
PK 7410 N	PK 7410 R		10000	60	110	585		

Measures without engagement

Capacity figures ± 10% Speed (r.p.m.) — 15%



VEM ENCASED MOTORS

for AC / DC

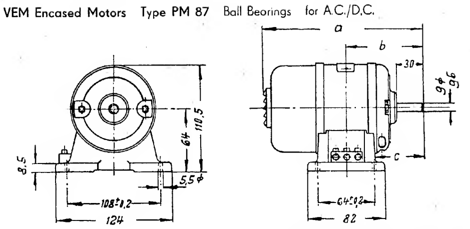
Design with brush bridge

Tension: 110–220 V

Capacity: 15–180 W

Speed: 2000/10000 rpm.

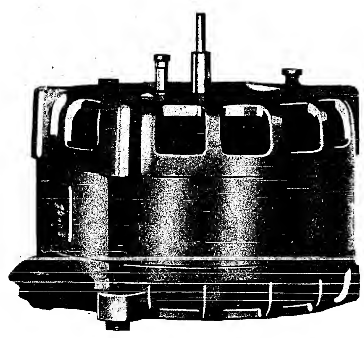
VEM Encased Motors Type PM 87 Ball Bearings for A.C./D.C.



Type	a	b	c
PM 87–30	173,5	85,5	53,5
PM 87–40	183,5	90,5	58,5
PM 87–60	203,5	100,5	68,5

No. for orders 110 V	No. for orders 220 V	Type	Speed rpm.	Capacity W	Wattage W	Torque cm g	Weight obt. kg	Weight obt. lbs.
P 832 N	P 832 R	PM 87–30	2000	15	45	730	2,3	5
P 833 N	P 833 R		3000	25	60	810		
P 834 N	P 834 R		4000	40	93	972		
P 835 N	P 835 R		5000	50	115	975		
P 836 N	P 836 R		6000	65	140	1050		
P 838 N	P 838 R		8000	90	180	1100		
P8310 N	P8310 R		10000	130	240	1260		
P 842 N	P 842 R	PM 87–40	2000	19	57	925	2,64	$5^{5}/_{6}$
P 843 N	P 843 R		3000	30	65	970		
P 844 N	P 844 R		4000	55	115	1340		
P 845 N	P 845 R		5000	65	135	1270		
P 846 N	P 846 R		6000	90	185	1460		
P 848 N	P 848 R		8000	100	205	1220		
P8410 N	P8410 R		10000	150	260	1460		
P 862 N	P 862 R	PM 87–60	2000	40	90	1950	3,37	$8^{1}/_{2}$
P 863 N	P 863 R		3000	55	115	1780		
P 864 N	P 864 R		4000	70	130	1700		
P 865 N	P 865 R		5000	90	185	1760		
P 866 N	P 866 R		6000	100	190	1640		
P 868 N	P 868 R		8000	120	210	1460		
P8610 N	P8610 R		10000	180	310	1750		

Measures without engagement Capacity figures ± 10% Speed (r.p.m.) — 15%



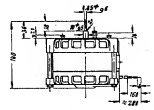
VEM SYNCHRONOUS MOTOR
FOR MAGNETIC RECORDER
TYPE MSM 130–30

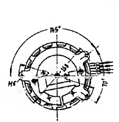
Slide Bearings

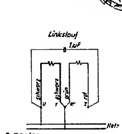
for A.C. 50 c.p.s.

19 cm. (obt. $7^{1}/_{2}$ inch.) p.s.

VEM Synchronous Motor for Magnetic Recorder
Type MSM 130—30 Slide Bearings for A.C. 50 c. p. s. 19 cm. p. s.





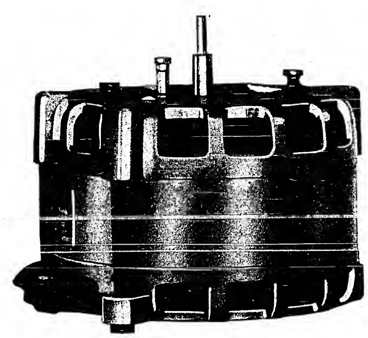


S. 599/20

The rotation direction may be altered by change of the green- red connection-cards of the auxiliar phases.

No. for orders 220 V	Type	Speed rpm.	Capacity W	Wattage W	Torque cm g	Weight abt. kg	lbs.
MSM 1337/19 R	MSM 130–30	750	6	37	780	4,7	$10^3/_8$

Measures without engagement Capacity figures ± 10%



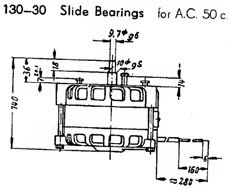
VEM SYNCHRONOUS MOTOR
FOR MAGNETIC RECORDER
TYPE MSM 130–30
Slide Bearings

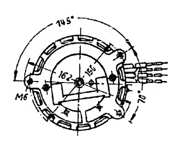
for A.C. 50 c. p. s.

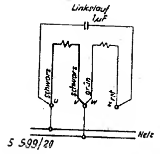
38 cm. (abt. 15 inch.) p. s.

VEM Synchronous Motor for Magnetic Recorder

Type MSM 130–30 Slide Bearings for A.C. 50 c.p.s. 38 cm.p.s.





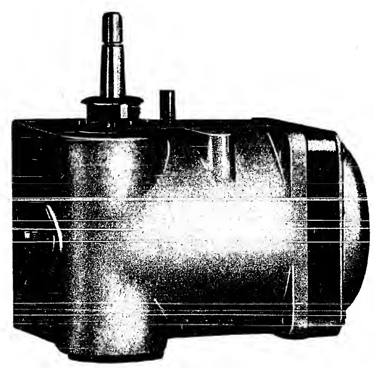


S 599/20

The rotation direction may be altered by change of the green- red connection-cords of the auxiliar phases.

No. for orders 220 V	Type	Speed rpm.	Capacity W	Wattage W	Torque cm g	Weight abt. kg	lbs.
MSM 1337/38 R	MSM 130–30	750	6	37	780	4,7	10 3/8

Measures without engagement   Capacity figures ± 10%



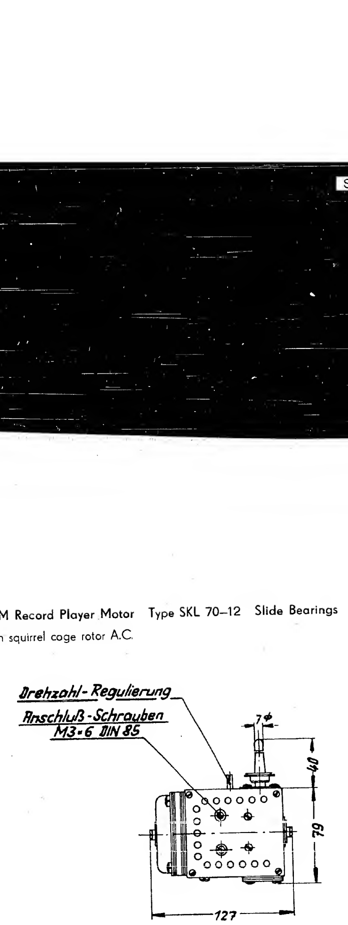
VEM RECORD PLAYER MOTOR

TYPE SKL 70–12

with Squirrel Cage Rotor for A.C.

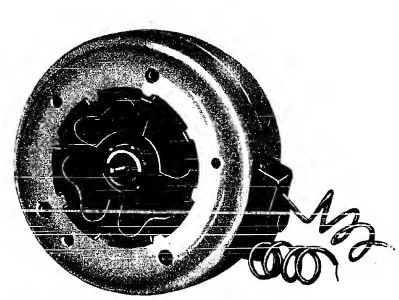
Slide Bearings

VEM Record Player Motor Type SKL 70–12 Slide Bearings
with squirrel cage rotor A.C.



No. for orders 110 V	220 V	Type	Speed rpm.	Capacity W	Wattage W	Torque cm g	Weight abt. kg	lbs.
SKL 718 N	SKL 718 R	SKL 70–12	78	1,2	15	1120	1	2¼

Measures without engagement   Capacity figures ± 10%



VEM SYNCHRONOUS MOTOR
TYPE SM 55

self-starting

for A.C. 50 c. p. s.

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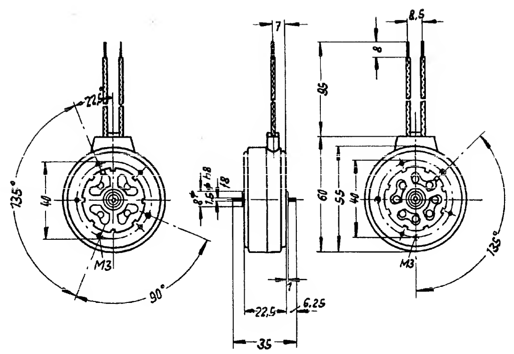
VEM Synchronous Motor Type SM 55
self-starting for A.C. 50 c.p.s.



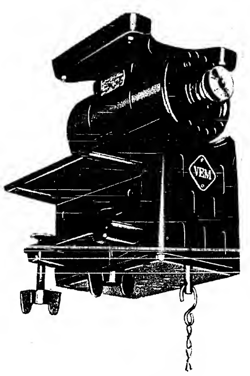
No. for orders 220 AC	Type	Speed r. p. m.	Wattage watts	Torques cmg Motor shaft	Gear shaft		Weight obt. kg	oz
SM 55 R	SM 55	375	about 3	0,8	start 240	synchr. 300	0,14	5

The inserted torques refer to a shaft with 1 r.p.m.

24 V, 42 V, 110 V, 380 V on request

Measures without engagement Capacity figures ± 10 %

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



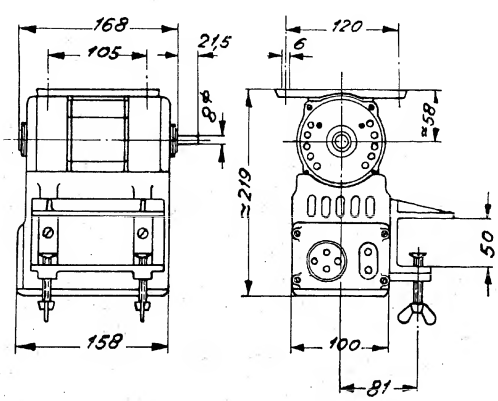
VEM SEWING MACHINE MOTORS
TYPE UNA 100

with junction for the sewing light
for AC/DC with built-in starter and brake device
for Industry and Home Work

The efficient and encased motor with silenced running is equipped with a best regulating starter and an instantaneously acting brake. A plug contact permits the direct connection of the sewing lamp or of a second motor. The motors have ball bearings and answer, therefore, the highest requirements in service. A great advantage of this motortype is secured by the convenient regulation of the speed as well as by the reduction of noise. The suitably constructed brake arrangement permits a quick stopping of the machine, and thus allows a sewing at high speed up to a few stitches before the end of the seam. The switching on or off is done over a pull-chain by means of a pedal of the operated machine. The motor can also be driven by a base plate as undertable motor or by a screw ferrule

for overtable fastening. To diminish the vibrations, the motor is placed in rubber buffers on thesaid plate. All revolving parts are dynamically levelled. The installed ventilator for the cooling of the machine permits a running also in shift work. The motor can be used either for A.C. or for D.C. As a rule the torque direction of these motors is to the left (anti-clockwise rotation), but may be changed according to the directions printed on next page.

Type	Capacity in watts	HP	Tension volts	Speed rpm.	Weight about kg	lbs.
UNA	100	$^{1}/_{7}$	110 or 220	4500	5,0	11



Directions for Attendance and Maintenance

of the VEM Sewing Machine Motor Type UNA 100

The motor is connected by a strong plug, and is equipped with a sufficient protection against interferences. For this purpose the encasing of the motor must have an earth-connection. According to the special requirements, the fastening of the motor with a screw ferrule can be done either on one side of the starter's encasing or on its other side thus permitting various operation possibilities. If, nevertheless, a change of the torque direction of the motor should be necessary, the following manner is recommended:

After taking off the protection cap, the two connections at the brushholders must be changed. By loosening the two guidenuts the brushring can be shifted to the opposite side. Attention must be paid that this ring is completely carried until the lock, as an incomplete shifting causes a decrease of the revolutions p. m. and consequently also a reduction of efficiency. After this manipulation the guidenuts have again to be driven home in a tight manner. The motors have been equipped with ball bearings since they are more sensible against shock and knock than slide bearings. By occasionally operating at the shaft stump, caution is therefore necessary. The belt connection must be effectuated with all property, and in consideration of the small diameter of the pulley, this connection must be sufficiently elastic. The bearings of the motor are provided with a grease-reserve for about 1500 to 2000 operating hours. When refilling the bearings, they should be cleaned with petroleum and provided with a new stiff grease, but not with Stauffer fat. The collector as well as the brushes must be kept clean, and it is thus recommended that examinations to this regard are accomplished from time to time, as usually dust of textile-fibres, which cannot be avoided in working, enters the interior of the motor. The cleaning may be made by means of a dry woollen duster. On such occasion, please do not forget to examine the condition of the collector and pay attention that the insulating plastics of the laminas stand back by about 0,3 mm. Overstanding insulating material causes firing and, in the consequence, a premature wear of the brushes. As a matter of course the mains plug is to take off before any manipulation at the motor is done. Should motors have taken up moisture, they should start again only after a careful drying.

Please inform us about possible damages, troubles and defects of the motors. We shall examine your information and endeavour to consider all proposals from the point of view of construction, material and last not least of constant improvement of the motor's qualities.

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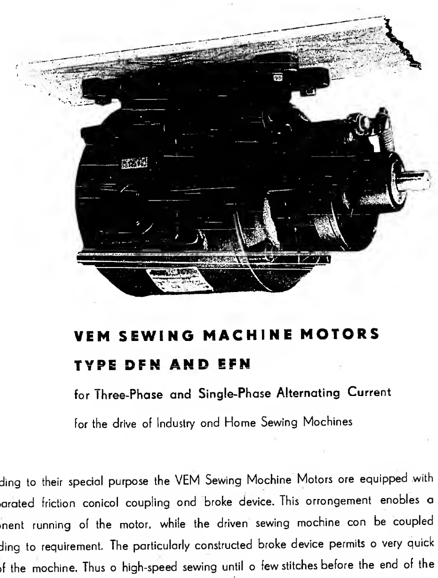

VEM SEWING MACHINE MOTORS

TYPE DFN AND EFN

for Three-Phase and Single-Phase Alternating Current

for the drive of Industry and Home Sewing Machines

According to their special purpose the VEM Sewing Machine Motors are equipped with incorporated friction conical coupling and brake device. This arrangement enables a permanent running of the motor, while the driven sewing machine can be coupled according to requirement. The particularly constructed brake device permits a very quick stop of the machine. Thus a high-speed sewing until a few stitches before the end of the seam is possible. On the other hand an immediate sewing at highest speed is attained by pedalling directly to the terminal position. The on- and off coupling is manipulated by a pull-chain by means of the pedal of the driven machine. The motor is to be installed in hanging or standing position. Loosening 4 fastening screws you may turn the coupling mechanism by about 90 or 180 degrees, according to the requirements. The base plate can as well be fastened at the motor case in the vertical or transversal direction.

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To diminish the vibrations of the motor, it is placed in rubber buffers on its base plate. All revolving parts are levelled dynamically. A good cooling of the motors is attained by well-adapted ventilators so that a permanent drive of the machines is possible, even in shift work. All motor types are distinguished by particularly high starting torque and tilting capacities. The power of traction at the coupling spring can by a special lever be regulated as required. As a norm, all machines are equipped with low tensioned sewing light of 12 volts, and this voltage can be taken from a simple mains plug. The wear of incandescent lamps is, thus, essentially reduced, and at the same time the prescriptions for accident protection are taken into consideration. The machines have an attractive shape, and highest requirements concerning their quality will be satisfied.

All EFN types are equipped with auxiliary windings and are started by a special auxiliary phase switch.

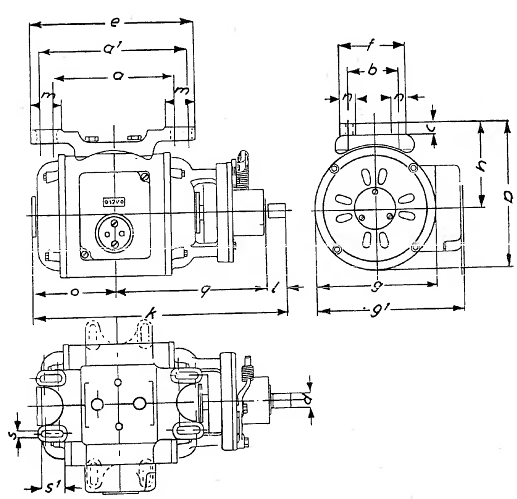
For the start of our sewing machine motors, we recommend in your own interest to use a protective motor switch, automatically protecting the windings from overload and failure of phases. It is comprehensible that the windings cannot be manufactured for an excess current which is 10 or 12 times higher than normal, but this is practically possible for ordinary 6 or 10 Amp. fusing.

a) Three-phase A.C. motors

Type	Capacity in		Speed	Weight abt.		Diameter of Groove Pulley	
	Watt	HP	rpm.	kg	lbs.	mm	inch.
DFN 22	180	1/4	2800	10,0	22	32	1,28
DFN 45	250	1/3	1400	16,5	37	65	2,60

b) Single-phase A.C. motors

Type	Capacity in		Speed	Weight abt.		Diameter of Groove Pulley	
	Watt	HP	rpm.	kg	lbs.	mm	inch.
EFN 22	180	1/4	2800	12,0	27	32	1,28
EFN 45	250	1/3	1400	19,5	43	65	2,60



After the loosening of the hexagon screws the base plate can be fixed in vertical and transversal direction of the motor.

Size	a	a1	b	c	d	e	f	g	g1	h	k	l	m	n	o	p	q	s	s1
DFN 22	140	170	60	15	16	190	80	143	172	100	296	25	35	20	94	171	177	10	25
EFN 22	140	170	60	15	16	190	80	143	172	100	316	25	35	20	104	171	187	10	25
DFN 45	170	200	100	15	16	225	125	180	210	115	304	25	40	25	97	205	182	12	27
EFN 45	170	200	100	15	16	225	125	180	210	115	324	25	40	25	107	205	192	12	27

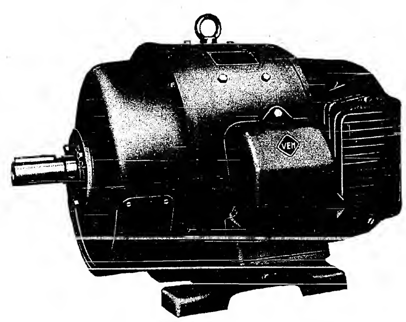
Directions for Attendance and Maintenance of the VEM Sewing Machine Motors

When connecting the motor, please consider the switch diagram, annexed in the terminal box, and pay particular attention to the working voltage (star- or delta-connection resp. one after another- or parallel switching of the operating winding for the EFN types).
Please take the cross-section of the extension-cords leading to the motor, according to the VDE specifications.
The melting fuse must, however, correspond at least to the starting current of the machine. The protective motor switch, between main fuse and machine, should be appropriated to the nominal current, as indicated on the capacity plate.
Should the protective motor switch often trip without an evident reason it will be to your own advantage to have the installation as soon as possible examined by an expert. The maintenance of the machines is very simple. It is restricted to relubrication of the ball bearings, should the large supply of grease from the date of delivery be consumed. The relubrication is necessary after about 1500 to 2000 operating hours.
Please inform us about possible damages, troubles and defects of the motors. We shall examine your information and endeavour to consider all proposals from the point of view of construction, material and last not least of constant improvement of the motor's qualities.

D. C. MOTORS   TYPES GNE – GHE – GCE

Type	Capacity in kW at 1500 rpm.	1000 rpm.	750 rpm.	600 rpm.	500 rpm.
521	300 b	190 b	140 a	105 a	80 a
523	350 c	220	160	120	90
525	300	250	180	135	100
621	450	290	200 b	160	120
623	540	340	240	190	150
625	630 d	400 c	290	220	180
721	730	450	335	260 b	210
723	850	540	390 c	300	245 b
725	1000	640	460	335	290

The D. C. motors are designed with shunt- (type GNE), series- (type GHE) or compound- excitation (type GCE) and are equipped with self- or separate ventilation. The latter design is type GNF.
Protective system: P 11 for sizes 521 – 625, P 00 for sizes 721 – 725.
Design: B 2, B 3, C 2 for sizes 521 – 625; D 2, D 5, D 6, D 13 for sizes 721 – 725.
Rated voltages: a 110, 220, 440 volts; b 220, 400 volts; c 440 volts; d more than 500 volts on request.
For motors with other voltages or speeds than those stated above, please send special enquiry.
If speed control is required please state the speed range and give information whether the control must be provided for constant capacity or for constant torque.



D.C. SHUNT-WOUND MOTORS

for swimming plants

Design B 3 *　　　　　Protective system P 22 *

The machines correspond to the "Regulations for valuation and examination of electric machines" VDE 0530 (German Electricians) resp. to the regulations of the DSRK (German Ship Revision and Classification).

*) Other designs and protective system as per our technical tables and principal diagrams.

D. C. shunt-wound motors for swimming plants

Design B 3
B 5, V 1, V 3
B 3/B 5, V 1/V 5, V 3/V 6

Protective system P 22

Type	Rated capacity kW	Rated capacity HP	Rate of efficiency abt. %	Input wattage abt. kW	Rated speed rpm.	Approx. weight kg	Approx. weight cwts.
No-load speed 3000 rpm.							
GMB 07	0,4	0,55	70	0,57	2800	17	0.1.9
GMB 08	0,65	0,9	73	0,89	2800	20	0.1.16
GMB 09	1	1,4	75	1,30	2800	35	0.2.21
GMB 1	1,6	2,2	77	2,1	2820	40	0.3.4
GMB 8	2,8	3,8	79,5	3,5	2820	52	1.0.2
GMB 3	4,4	6	81	5,4	2850	65	1.1.3
GMB 4	6	8,2	82	7,3	2850	95	1.3.13
GMB 5	8,2	12	83	10,2	2850	120	2.1.13
GMB 6	12	16	84,5	14,2	2880	170	3.1.11
GMB 7*)	18	25	85,5	21	2880	190	3.2.26
GMB 18*)	24	33	86	28	2900	215	4.0.26
GMB 19*)	35	48	87	40	2900	240	4.2.25
GMB 10	—	—	—	—	—	315	6.0.22
GMB 11	—	—	—	—	—	475	9.1.11
GMB 12	—	—	—	—	—	530	10.1.20
GMB 13	—	—	—	—	—	720	14.0 22
GMB 14	—	—	—	—	—	900	17 2 24
GMB 15	—	—	—	—	—	1100	21.2.17
GMB 16	—	—	—	—	—	1400	27.2.7
GMB 17	—	—	—	—	—	1600	31.2.2
GMB 18	—	—	—	—	—	2200	43.0.0
GMB 19	—	—	—	—	—	2500	49.0.0

*) For 220/440 volts only

Rated voltages 110, 220, 440 volts. Rate of efficiency for 110 volts 1% lower.

D. C. shunt-wound motors for swimming plants

Design B 3
B 5, V 1, V 3
B 3/B 5, V 1/V 5, V 3/V 6

Protective system P 22

Type	Rated capacity kW	Rated capacity HP	Rate of efficiency abt. %	Input wattage abt. kW	Rated speed rpm.	Approx. weight kg	Approx. weight cwts.
No-load speed 1500 rpm.							
GMB 07	0,2	0,25	66	0,30	1400	17	0.1.9
GMB 08	0,32	0,45	69	0,46	1400	20	0 1.16
GMB 09	0,5	0,7	71	0,7	1400	35	0.2.21
GMB 1	0,8	1,1	74	1,1	1410	40	0.3.4
GMB 2	1,3	1,9	79	1,8	1410	52	1.0 2
GMB 3	2,2	3	78	2,8	1420	65	1.1.3
GMB 4	3	4,1	80	3,75	1420	95	1.3.13
GMB 5	4,2	5,7	81	5,2	1430	120	2.1.13
GMB 6	6	8,2	82	7,3	1430	170	3 1.11
GMB 7	9	12	83,5	10,8	1440	190	3.2.26
GMB 8	12	16	84,5	14,2	1440	215	4.0.26
GMB 9	18	25	85,5	21	1440	240	4 2.25
GMB 10	26	35	86,5	30	1450	315	6 0.22
GMB 11	35	48	87,5	40	1450	475	9 1.11
GMB 12	46	63	88,5	52	1460	530	10.1.20
GMB 13*)	59	80	89	66,7	1460	720	14.0.22
GMB 14*)	75	102	89,5	84	1460	900	17.2.24
GMB 15*)	94	128	90	105	1460	1100	21.2.17
GMB 16*)	116	158	90,5	128	1470	1400	27.2.7
GMB 17*)	150	204	91	165	1470	1600	31 2.2
GMB 18**)	190	258	91,5	208	1470	2200	43.0.0
GMB 19**)	235	320	91,5	257	1470	2500	49.0.0

*) For 220/440 volts only
**) For 460 volts only

Rated voltages 110, 220, 440 volts. Rate of efficiency for 110 volts 1% lower.

D. C. shunt-wound motors for swimming plants

Design B 3
B 5, V 1, V 3
B 3/B 5, V 1/V 5, V 3/V 6

Protective system P 22

Type	Rated capacity kW	Rated capacity HP	Rate of efficiency abt. %	Input wattage abt. kW	Rated speed rpm.	Approx. weight kg	Approx. weight cwts.
No-load speed 1000 rpm.							
GMB 07	0,12	0,15	59	0,20	910	17	0.1.9
GMB 08	0,2	0,25	62	0,32	920	20	0.1.16
GMB 09	0,3	0,4	65	0,46	920	35	0.2.21
GMB 1	0,5	0,7	68	0,74	930	40	0.3.4
GMB 2	0,8	1,1	70,5	1,13	930	52	1.0.2
GMB 3	1,3	1,8	73,5	1,77	940	65	1.1.3
GMB 4	1,8	2,5	75	2,4	940	95	1.3.13
GMB 5	2,5	3,4	77	3,25	940	120	2.1.13
GMB 6	3,7	5	78,5	4,73	950	170	3.1.11
GMB 7	5,4	7,3	80,5	6,7	950	190	3.2.20
GMB 8	7,5	10	82	9,2	950	215	4.0.26
GMB 9	11	15	83,5	13,2	950	240	4.2.25
GMB 10	16	22	85	18,8	960	315	6 0.22
GMB 11	22	30	86	25,6	960	475	9.1 11
GMB 12	29	39	87	33,4	960	530	10.1.20
GMB 13	37	50	88	42	900	720	14.0.22
GMB 14*)	48	65	88,5	54,3	970	900	17.2.24
GMB 15*)	60	82	89,5	67	970	1100	21.2.17
GMB 16*)	77	105	90	85,6	970	1400	27.2 7
GMB 17*)	98	133	90,5	108	970	1600	31.2.2
GMB 18*)	123	167	91	135	980	2200	43.0.0
GMB 19*)	154	209	91	169	980	2500	49.0.0

*) For 220/440 volts only

Rated voltages 110, 220, 440 volts. Rate of efficiency for 110 volts 1% lower.

D. C. shunt-wound motors for swimming plants

Design B 3
B 5, V 1, V 3
B 3/B 5, V 1/V 5, V 3/V 6

Protective system P 22

Type	Rated capacity kW	Rated capacity HP	Rate of efficiency abt. %	Input wattage abt. kW	Rated speed rpm.	Approx. weight kg	Approx. weight cwts.
No-load speed 750 rpm.							
GMB 07	—	—	—	—	—	17	0.1.9
GMB 08	—	—	—	—	—	20	0.1.16
GMB 09	—	—	—	—	—	35	0.2.21
GMB 1	—	—	—	—	—	40	0.3.4
GMB 2	0,5	0,7	67	0,75	700	52	1.0.2
GMB 3	0,8	1,1	69,5	1,15	700	65	1.1.3
GMB 4	1,2	1,6	72	1,66	700	95	1.3.13
GMB 5	1,7	2,3	74	2,3	700	120	2.1.13
GMB 6	2,5	3,4	76	3,3	700	170	3.1.11
GMB 7	3,6	4,9	77,5	4,7	700	190	3.2.26
GMB 8	5,4	7,3	79,5	6,8	710	215	4.0.26
GMB 9	7,8	11	81,5	9,6	710	240	4.2.25
GMB 10	11	15	82,5	13,3	710	315	6 0.22
GMB 11	16	22	84	19	710	475	9.1.11
GMB 12	21	29	85	24,7	720	530	10.1.20
GMB 13	27	37	86	31,4	720	720	14.0.22
GMB 14	35	48	87	40 2	720	900	17.2.24
GMB 15	44	60	88	50	720	1100	21.2.17
GMB 16	56	76	88,5	63,3	730	1400	27.2.7
GMB 17*)	72	98	89	81	730	1600	31.2.2
GMB 18*)	90	122	90	100	730	2200	43.0.0
GMB 19*)	113	154	90,5	125	730	2500	49.0.0

*) For 220/440 volts only

Rated voltages 110, 220, 440 volts. Rate of efficiency for 110 volts 1% lower.

D. C. shunt-wound motors for swimming plants

Design B 3
B 5, V 1, V 3
B 3/B 5, V 1/V 5, V 3/V 6

Protective system P 22

Type	Rated capacity kW	Rated capacity HP	Rate of efficiency abt. %	Input wattage abt. kW	Rated speed rpm.	Approx. weight kg	Approx. weight cwts.
No-load speed 600 rpm.							
GMB 07	—	—	—	—	—	17	0.1.9
GMB 08	—	—	—	—	—	20	0.1.16
GMB 09	—	—	—	—	—	35	0.2.21
GMB 1	—	—	—	—	—	40	0.3.4
GMB 2	—	—	—	—	—	52	1.0.2
GMB 3	—	—	—	—	—	65	1.1.3
GMB 4	0,8	1,1	66	1,21	550	95	1.3.13
GMB 5	1,2	1,6	69	1,74	550	120	2.1.13
GMB 6	1,8	2,5	71,5	2,52	550	170	3.1.11
GMB 7	2,6	3,5	74	3,52	550	190	3.2.26
GMB 8	3,8	5,2	76	5	550	215	4.0.26
GMB 9	5,6	7,6	78	7,2	550	240	4.2.25
GMB 10	8,5	12	80,5	10,8	560	315	6.0.22
GMB 11	12	16	82	14,6	560	475	9.1.11
GMB 12	16	22	83,5	19,2	560	530	10.1.20
GMB 13	20	27	84,5	23,7	560	720	14.0.22
GMB 14	27	37	86	31,4	570	600	17.2.24
GMB 15	34	46	87	39	570	1100	21.2.17
GMB 16	43	58	87,5	49	570	1400	27.2.7
GMB 17	55	75	88,5	62	570	1600	31.2.2
GMB 18	70	95	89	79	580	2200	43.0.0
GMB 19	87	118	89,5	97	580	2500	49.0.0

Rated voltages 110, 220, 440 volts. Rate of efficiency for 110 volts 1% lower.

D. C. shunt-wound motors for swimming plants

Design B 3
B 5, V 1, V 3
B 3/B 5, V 1/V 5, V 3/V 6

Protective system P 22

Type	Rated capacity kW	Rated capacity HP	Rate of efficiency abt. %	Input wattage abt. kW	Rated speed rpm.	Approx. weight kg	Approx. weight cwts.
No-load speed 500 rpm.							
GMB 07	—	—	—	—	—	17	0.1.9
GMB 08	—	—	—	—	—	20	0.1.16
GMB 09	—		—	—	—	35	0.2 21
GMB 1	—	—	—	—	—	40	0.3.4
GMB 2	—	—	—	—	—	52	1.0.2
GMB 3	—	—	—	—	—	65	1.1.3
GMB 4	—	—	—	—	—	95	1.3.13
GMB 5	—	—	—	—	—	120	2.1.13
GMB 6	1,2	1,6	67	1,8	460	170	3.1.11
GMB 7	1,7	2,3	69,5	2,45	460	190	3.2.26
GMB 8	2,6	3,5	72	3,6	460	215	4.0.26
GMB 9	3,8	5,2	74,5	5,1	460	240	4.2.25
GMB 10	6	8,2	77,5	7,75	460	315	6.0.22
GMB 11	8,2	11	79	10,3	470	475	9.1.11
GMB 12	12	16	81	14,8	470	530	10.1.20
GMB 13	15	20	82	18,3	470	720	14.0.22
GMB 14	20	27	83,5	24	470	900	17.2.24
GMB 15	26	35	84,5	30,8	470	1100	21.2.17
GMB 16	33	45	85,5	39	480	1400	27.2.7
GMB 17	43	58	86,5	50	480	1600	31.2.2
GMB 18	54	73	87,5	62	480	2200	43 0.0
GMB 19	67	91	88	76	480	2500	49.0.0

Rated voltages 110, 220, 440 volts. Rate of efficiency for 110 volts 1% lower.

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D. C. shunt-wound motors for swimming plants

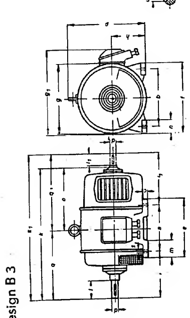
Design B 3, B 5, V 1, V 3 — Protective system P 33

Type	Rated capacity kW	Rated capacity HP	Rated speed rpm.	Approx. weight kg	Approx. weight cwts.
GMG 07	0,13	0,2	1400	17	0.1.9
GMG 08	0,18	0,25	1400	20	0.1.16
GMG 09	0,3	0,4	1400	35	0.2.21
GMG 1	0,4	0,55	1400	40	0.3.4
GMG 2	0,6	0,8	1400	52	1.0.2
GMG 3	0,85	1,2	1400	65	1.1.3
GMG 4	1,1	1,5	1400	95	1.3.13
GMG 5	1,4	1,9	1400	120	2.1.13
GMG 6	2	2,7	1400	170	3.1.11
GMG 7	2,5	3,4	1400	190	3.2.26
GMG 8	3,4	4,6	1400	215	4.0.26
GMG 9	4,5	6,1	1400	240	4.2.25
GMG 10	6	8,2	1400	315	6.0.22
GMG 11	7,5	10	1400	475	9.1.11
GMG 12	9,5	13	1400	530	10.1.20
GMG 13	12	16	1400	720	14.0.22

*) Further dates on request.

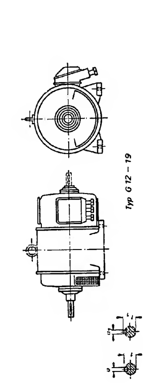
Voltages 110, 230, 460 volts. Rate of efficiency for 110 volts 1% lower.

Design B 3



Typ G 07 – 11

Protective system P 21



Typ G 12 – 19

Typ G	a	b	c	e	f	g	g_1	h	i	k 1)	k 2)	m	n	o 1)	o 2)	p	q	s	Wellenende d	Wellenende l	Wellenende t	Wellenende u	Zweites Wellenende 3) d_1	i_1	k_1 1)	k_1 2)	l_1	q_1 1)	q_1 2)	t_1	u_1
07	115	140	12	140	175	172	235	90 -0,5	95	308	—	40	35	156	—	221	152	9,5	14 j6	30	16,1	5	14 k6	128,5	338	—	30	166		16,1	5
08	140			165						333	—			168	—		165							128	363	—		198			
09	135	185	16	185	225	215	283	112 -0,5	140,5	429	—	50	40	221	—	264	208	11,5	18 j6	40	20,5	6	14 k6	163,5	459	—	30	251		16,1	5
1	170			200						465	—			240	—		225							185	495	—		270			
2	160	230	20	200	280	270	346	140 -0,5	170	504	—	60	50	254	—	320	250	14	22 j6	50	24,5	6	18 k6	214	544	—	40	294		20,5	6
3	200			240						544	—			274	—		270								584	—		314			
4	180	270	25	230	330	315	409	160 -0,5	195	575	—	75	60	290	—	363	285	14	28 k6	60	30,9	8	22 k6	250	625	—	50	340		24,5	6
5	210			260						605	—			305	—		300								655	—		355			
6	220	330	28	280	400	385	477	200 -0,5	240	678	—	90	70	328	—	445	350	18	38 k6	80	41,3	10	28 k6	278	738	—	60	386		30,9	8
7	260			320						718	—			348	—		370								778	—		408			
8	250	370	32	330	450	442	557	225 -0,5	293	613	—	110	80	395	—	507	418	23	48 k6	110	48,5	14	38 k6	350	893	—	60	475		41,3	10
9	300			380						863	925			420	482		443								943	1005		500	562		
10	270	450	40	365	550	550	698	280 -1	315	900	965	120	100	450	515	625	450	27	55 m6	110	58,8	16	45 k6	425	1010	1075	110	660	625	48,5	14
11	310			405						940	1005			470	535		470								1050	1115		580	645		
12	315	510	45	410	630	615	749	315 -1	363,5	1021	1105	135	120	500	564	695	521	27	65 m6	140	69,2	18	55 m6	452,5	1131	1215	110	610	694	58,8	16
13	350			445						1056,5		—		516			538,5							453	1166,5			628			
14	380	580	50	475	705	695	817	355 -1	360	1137		—	125	567		813	550	27	75 m6	140	79,6	20	65 m6	537	1277		140	727		69,2	18
15	420			515						1237				667			570							597	1377			807			
16	390	650	55	500	790	780	930	400 -1	380	1268		—	140	713		918	575	33	80 m6	170	85,5	22	75 m6	658	1428		140	853		79,6	20
17	450			560						1348				743			605		85 m6		90,5				1488			883			
18	410	210	60	520	870	850	1010	450 -1	395	1367		—	160	767		1054	600	33	90 m6	170	95,3	25	85 m6	732	1537		170	937		90,3	22
19	470			580						[illegible]				797			630		95 m6		100,3		90 m6		1597			967		95,3	

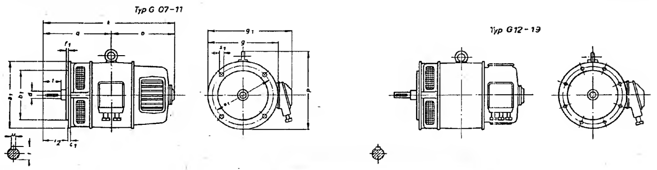
Typ = Type — Wellenende = Shaft stump — Zweites Wellenende = Second shaft stump

1) Measures beginning with 220 volts working voltage 2) Measures for 110 volts working voltage: beginning with type G 13 the supplier chooses the suitable type for motors with a working voltage of 110 volts 3) The second shaft stump must be specially ordered.

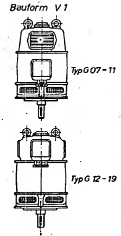
Design B 5, V 1, V 3

Design B 5

Protective system P 21

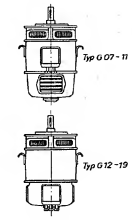


Bauform V 1



Typ G	a_1	b_1	c_1	s_1	Anzahl der Bohrung	e_1	f_1	g	g_1	p	k 1)	k 2)	o 1)	o 2)	q	l_2	Wellenende d	Wellenende l	Wellenende t	Wellenende u
07	120	80 j6	8	M6	4	100	3	172	234	217	308	—	156	—	152	35	14 k6	30	16,1	5
08											333	—	168	—	165					
09	160	110 j6	10	9,5	4	130	3,5	215	278	260	429	—	221	—	208	45	18 k6	40	20,5	6
1											465	—	240	—	225					
2	250	180 j6	16	14	4	215	4	270	341	315	504	—	254	—	250	55	22 k6	50	24,5	6
3											544	—	274	—	270					
4	250	180 j6	16	14	4	215	4	315	402	361	575	—	290	—	285	65	28 k6	60	30,9	8
5											605	—	305	—	300					
6	300	230 j6	20	14	4	265	4	385	470	438	678	—	328	—	350	85	38 k6	80	41,3	10
7											718	—	348	—	370					
8	350	250 h6	20	18	4	300	5	442	553	503	813	—	395	—	418	118	45 k6	110	48,5	14
9											863	925	420	482	443					
10	450	350 h6	22	18	8	400	5	550	698	620	900	965	450	515	450	118	55 m6	110	58,5	16
11											940	1005	470	535	470					
12	550	450 h6	22	18	8	500	5	615	741	688	1021	1105	500	584	521	148	65 m6	140	69,2	19
13											1056,5		518		538,5					
14	660	550	25	23	8	600	6	695	812	900	1137		587		550	150	75 m6	140	79,6	20
15											1237		667		570					
16	800	680	25	23	8	740	6	780	925	908	1288		713		575	180	80 m6	170	85,5	22
17											1348		743		605		85 m6		90,5	
18	1000	880	30	23	8	940	6	850	1000	980	1367		767		600	180	90 m6	170	95,3	25
19											1427		797		630		95 m6		100,3	

Bauform V 3

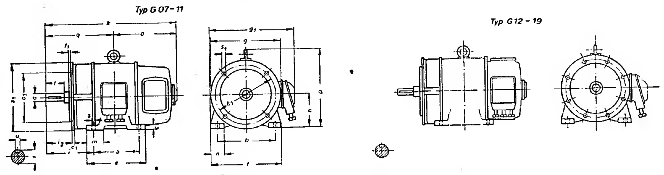


Bauform = Design Typ = Type Wellenende = Shaft end Anzahl der Bohrung = Number of bores [1]) Measures beginning with 220 volts of working voltage
[2]) Measures of 110 volts of working voltage; beginning with type G 13 the supplier chooses the suitable type for motors with a working voltage of 110 volts.

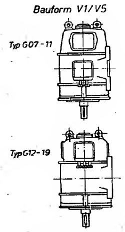
Design B 3/B 5, V 1/V 5, V 3/V 6

Design B 3/B 5

Protective system P 21



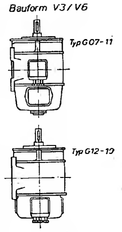
Bauform V1/V5



Typ G	a	b	c	e	f	g	g_1	h	i	k 1)	k 2)	m	n	o 1)	o 2)
07	115	140	12	140	175	172	235	90 −0,5	95	308		40	35	156	
08	140			165						333				168	
09	135	185	16	165	225	215	283	112 −0,5	140,5	429		50	40	221	
1	170			200						465				240	
2	160	230	20	200	280	270	346	140 −0,5	143	477		60	50	254	
3	200			240						517				274	
4	180	270	25	230	330	315	409	160 −0,5	153	533		75	60	290	
5	210			260						563				305	
6	220	330	28	280	400	385	477	200 −0,5	205	643		90	70	328	
7	260			320						683				348	
8	250	370	32	330	450	442	557	225 −0,5	248	768		110	80	395	
9	300			380						818	880			420	482
10	270	450	40	365	550	550	698	280 −1	268	853	918	120	100	450	515
11	310			405						893	958			470	535
12	315	510	45	410	630	615	749	315 −1	303,5	961	1045	135	120	500	584
13	350			445						898,5				518	
14	380	580	50	475	705	695	817	355 −1	320	1097			125	587	
15	420			515						1187				667	
16	390	650	55	500	790	780	930	400 −1	375	1283			140	713	
17	450			560						1343				743	
18	410	710	60	520	870	850	1010	450 −1	380	1352			160	767	
19	470			580						1412				797	

Typ G	p	q	s	a_1	b_1	c_1	s_1	Anz. d. Bohr.	e_1	f_1	l_2	Wellenende d	Wellenende l	Wellenende t	Wellenende u
07	221	152	9,5	120	80 j6	8	M6	4	100	3	35	14 k6	30	16,1	5
08		165													
09	[illegible]	208	11,5	160	110 j6	10	9,5	4	130	3,5	45	18 k6	40	20,5	6
1		225													
2	320	223	14	250	180 j6	16	14	4	215	4	55	22 k6	50	24,5	6
3		243													
4	363	243	14	250	180 j6	16	14	4	215	4	65	28 k6	60	30,8	8
5		258													
6	445	315	18	300	230 j6	20	14	4	265	4	85	38 k6	80	41,3	10
7		335													
8	507	373	23	350	250 h6	20	18	4	300	5	118	45 k6	110	48,5	14
9		398													
10	625	403	27	450	350 h6	22	18	8	400	5	118	55 m6	110	58,5	16
11		423													
12	695	461	27	550	450 h6	22	18	8	500	5	148	65 m6	140	69,7	18
13		478,5													
14	813	510	27	660	550	25	23	8	600	6	150	75 m6	140	79,6	20
15		530													
16	918	570	33	800	680	25	23	8	740	6	180	80 m6	170	85,5	22
17		600										85 m6		90,5	
18	1004	585	33	1000	880	30	23	8	940	6	180	90 m6	170	95,3	25
19		615										95 m6		100,3	

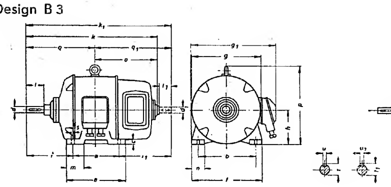
Bauform V3/V6



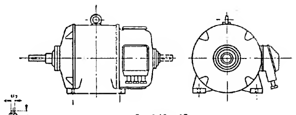
Bauform = Design Typ = Type Wellenende = Shaft end Anzahl der Bohrungen = Number of bores [1]) Measures beginning with 220 volts of working voltage
[2]) Measures for 110 volts of working voltage: beginning with type G 13 the supplier chooses the suitable type for motors with a working voltage of 110 volts.

Design B 3

Protective system P 33



Typ G 07–11



Typ G 12 – 19

Typ G	a	b	c	e	f	g	g_1	h	i	k 1)	k 2)	m	n	o 1)	o 2)	p	q	s	Wellenende d	Wellenende l	Wellenende t	Wellenende u	Zweites Wellenende 3) d_1	l_1	k_1 1)	k_1 2)	l_1	q_1 1)	q_1 2)	t_1	u_1
07	115	140	12	140	175	172	236	90 −0,5	95	308	—	40	35	158	—	221	152	9,5	14 k6	30	16,1	5	14 k6	128,5	338	—	30	186		16,1	5
08	140			165						333	—			168	—		165							128	363	—		198			
09	125	185	16	165	225	215	283	112 −0,5	140,5	428	—	50	40	221	—	264	208	11,5	18 k6	40	20,5	6	14 k6	183,5	459	—	20	251		16,1	5
1	170			200						465	—			240	—		225							185	495	—		270			
2	180	230	20	200	280	270	246	140 −0,5	143	477	—	60	50	254	—	320	223	14	22 k6	50	24,5	8	18 k6	214	517	—	40	294		20,5	6
3	200			240						517	—			274	—		243								557	—		214			
4	180	270	25	230	230	315	409	160 −0,5	153	533	—	75	60	290	—	362	243	14	28 k6	60	30,9	8	22 k6	250	583	—	50	340		24,5	6
5	210			280						562	—			305	—		258								613	—		355			
6	220	330	28	280	400	385	477	200 −0,5	205	643	—	90	70	328	—	445	315	18	38 k6	80	41,3	10	28 k6	278	703	—	60	388		30,9	8
7	260			320						683	—			348	—		335								743	—		408			
8	250	370	22	330	450	442	557	225 −0,5	248	788	—	110	80	395	—	507	373	23	45 k6	110	48,5	14	38 k6	350	848	—	80	475		41,3	10
9	300			380						818	880			420	482		398								898	960		500	562		
10	270	450	40	365	550	550	898	280 −0,5	268	853	918	120	100	450	515	625	403	27	55 m6	110	58,8	16	45 k6	425	963	1028	110	560	625	48,5	14
11	210			405						892	958			470	535		422								1003	1068		580	645		
12	315	510	45	410	620	815	749	315 −1	303,5	961	1045	135	120	500	584	695	461	27	65 m6	140	69,2	18	55 m6	452,5	1071	1156	110	610	684	58,8	18
13	350			445						996,5		—		518			478,5							453	1106,5			628			
14	380	580	50	475	705	695	817	355 −1	320	1097		—	125	587		612	510	27	75 m6	140	79,8	20	65 m6	537	1237		140	727		69,2	18
15	420			515						1197				667			530							597	1337			807			
16	390	850	55	500	780	780	930	400 −1	375	1283		—	140	713		918	570	33	80 m6	170	85,5	22	75 m6	858	1422		140	852		79,8	20
17	450			880						1243				743			600		85 m6		90,5				1483			882			
18	410	710	60	520	870	850	1010	450 −1	380	1352		—	160	787		1004	585	33	90 m6	170	95,3	25	85 m6	732	1522		170	927		90,3	22
19	470			580						1412				797			815		95 m6		100,3		90 m6		1582			967		95,3	

Typ = Type Wellenende = Shaft stump Zweites Wellenende = Second shaft stump

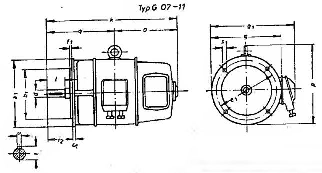
1) Measures beginning with 220 volts working voltage 2) Measures for 110 volts working voltage: beginning with type G 13 the supplier chooses the suitable type for motors with a working voltage of 110 volts 3) The second shaft stump must be specially ordered.

Design B 5, V 1, V 3

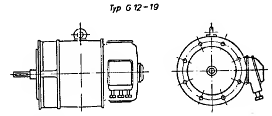
Design B 5

Protective system P 33

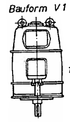
Typ G 07–11



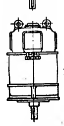
Typ G 12–19



Bauform V 1



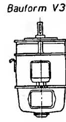
Typ G 07–11



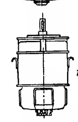
Typ G 12–19

Typ G	a_1	b_1	c_1	s_1	Anzahl der Bohrungen	e_1	f_1	g	g_1	p	k 1)	k 2)	o 1)	o 2)	q	l_2	Wellenende d	Wellenende l	Wellenende t	Wellenende u
07	120	80 j6	8	M6	4	100	3	172	234	217	308		156		152	35	14 k6	30	16,1	5
08											333		168		185					
09	160	110 j6	10	9,5	4	130	3,5	215	278	260	427		221		208	45	18 k6	40	20,5	6
1											465		240		225					
2	250	130 j6	16	14	4	215	4	270	341	315	477		254		223	55	22 k6	50	24,5	6
3											517		274		243					
4	250	160 j6	16	14	4	215	4	315	402	361	533		290		243	65	28 k6	60	30,9	6
5											563		305		256					
6	300	230 j6	20	14	4	285	4	385	470	428	643		328		315	85	38 k6	80	41,3	10
7											682		348		335					
8	350	250 h6	20	18	4	200	5	442	553	503	768		395		273	118	45 k6	110	48,5	14
9											818	880	420	482	398					
10	450	350 h6	22	18	8	400	5	550	698	620	853	918	450	515	403	118	55 m6	110	58,5	16
11											893	958	470	535	422					
12	550	450 h6	22	18	8	600	5	615	741	688	981	1045	500	584	461	148	65 m6	140	69,2	18
13											996,5		518		478,5					
14	680	550	25	23	8	600	6	695	812	808	1097		587		510	150	75 m6	140	79,6	20
15											1197		667		530					
16	800	680	25	22	8	740	6	780	925	808	1283		713		570	180	80 m6	170	85,5	22
17											1243		743		600		85 m6		90,5	
18	1000	880	30	23	6	840	8	650	1000	880	1252		787		585	180	90 m6	170	95,3	25
19											1412		797		615		95 m6		100,3	

Bauform V 3



Typ G 07–11



Typ G 12–19

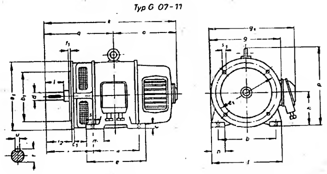
1) Bauform = Design Typ = Type Wellenende = Shaft end Anzahl der Bohrung = Number of bores 1) Measures beginning with 220 volts of working voltage 2) Measures for 110 volts of working voltage: beginning with type G 13 the supplier chooses the suitable type for motors with a working voltage o. 110 volts.

Design B 3/B 5, V 1/V 5, V 3/V 6

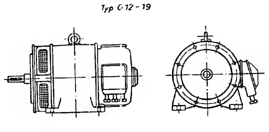
Protective system P 33

Typ G 07-11

Design B 3/B 5



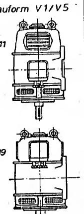
Typ G 12-19



Bauform V 1/V 5

Typ G07-11

Typ G 12-19

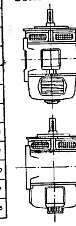


Typ G	a	b	c	e	f	g	g1	h	i	k 1)	k 2)	m	n	o 1)	o 2)	p	q	s	a1	b1	c1	s1	Anz. d. Bohrg.	e1	f1	f2	Wellenende d	Wellenende l	Wellenende t	Wellenende u
07	115	140	12	140	175	172	235	90 -0,5	95	308	—	40	35	156	—	221	152	9,5	120	80 j6	8	M6	4	100	3	35	14 k6	30	16,1	5
08	140			165						333	—			168	—		165													
09	135	185	16	165	225	215	283	112 -0,5	140,5	429	—	50	40	221	—	264	208	11,5	160	110 j6	10	9,5	4	130	3,5	45	18 k6	40	20,5	6
1	170			200						465	—			240	—		225													
2	160	230	20	200	280	270	346	140 -0,5	170	504	—	60	50	254	—	320	250	14	250	180 j6	16	14	6	215	4	55	22 k6	50	24,5	6
3	200			240						544	—			274	—		270													
4	180	270	25	230	330	315	409	160 -0,5	195	575	—	75	60	290	—	363	285	14	250	180 j6	16	14	4	215	4	65	28 k6	60	30,9	8
5	210			260						605	—			305	—		300													
6	220	330	28	280	400	385	477	200 -0,5	240	678	—	90	70	328	—	445	350	18	300	230 j6	20	14	4	265	4	85	38 k6	80	41,3	10
7	260			320						718	—			348	—		370													
8	260	370	32	330	450	442	557	225 -0,5	293	813	—	110	80	395	—	[illegible]	418	23	350	250 h6	20	18	4	300	5	118	45 k6	110	48,5	14
9	300			380						863	925			420	482		443													
10	270	450	40	365	550	550	698	280 -1	315	900	965	120	100	450	515	625	450	27	450	350 h6	22	18	8	400	5	118	55 m6	110	58,5	16
11	310			405						940	1005			470	535		470													
12	315	510	45	410	630	615	749	315 -1	363,5	1071	1105	135	120	500	584	695	521	27	550	450 h6	22	18	8	500	5	148	65 m6	140	69,2	18
13	350			445						1098,5				518			538,5													
14	380	580	50	475	705	695	817	355 -1	360	1137		—	125	587		813	550	27	660	550	25	23	8	600	6	150	75 m6	140	79,6	20
15	420			515						1237				667			570													
16	390	650	55	500	790	780	930	400 -1	380	1288		—	140	713		918	575	33	800	680	25	23	8	740	6	180	80 m6	170	85,5	22
17	450			560						1348				743			605										85 m6		90,5	
18	410	710	60	520	870	850	1010	450 -1	395	1367		—	160	767		1004	600	33	1000	880	30	2[illegible]	8	944	6	180	90 m6	170	95,3	25
19	470			580						1427				797			630										95 m6		100,3	

Bauform V 3/ V 6

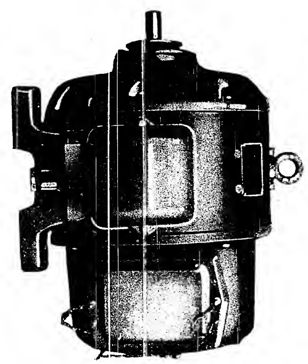
Typ G07-11

Typ G12-19



Bauform = Design Typ = Type Wellenende = Shaft end Anzahl der Bohrung = Number of bores 1) Measures beginning with 220 volts of working voltage
2) Measures for 110 volts of working voltage; beginning with type G 13 the supplier chooses the suitable type for motors with a working voltage of 110 volts.

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



D.C. SHUNT-WOUND MOTORS FOR LIFTS

Design B 3

Protective system P 33

with commutating poles

with compound winding

D. C. shunt-wound motors for lifts

Design B 3

Protective system P 33, with commutating poles and compound winding

Standard voltages 220 or 440 volts

Type	Rated capacity kW	Rated capacity HP	Rated speed rpm.	Current input at 220 V abt. amp.	Current input at 440 V abt. amp.	Moment of inertia GD^2 kgm^2	Approx. net weight kg	Approx. net weight cwts.
Base speed 1500 rpm. 40 % ED								
GMG 2 A	1,6	2,2	1420	9,8	4,9	0,036	70	1.1.14
GMG 3 A	2,5	3,4	1430	15	7,5	0,043	80	1.2.8
GMG 4 A	3,5	4,75	1440	20,4	10,2	0,13	100	1.3.24
GMG 5 A	5	6,8	1440	28,5	14,2	0,175	130	2.2.6
GMG 6 A	6,6	9	1450	37	18,5	0,23	180	3.2.4
GMG 7 A	9	12,2	1450	50	25	0,33	230	4.2.3
GMG 8 A	12	16,3	1460	65	32,5	0,57	265	5.0.24
GMG 9 A	17	23	1460	92	46	0,95	310	6.0.11
Base speed 1500 rpm. 25 % ED								
GMG 2 A	1,92	2,6	1420	11,6	5,8	0,036	70	1.1.14
GMG 3 A	3	4,1	1430	17,4	8,7	0,043	80	1.2.8
GMG 4 A	4,2	5,7	1440	24	12	0,13	100	1.3.24
GMG 5 A	6	8,2	1440	34	17	0,175	130	2.2.6
GMG 6 A	7,9	10,8	1450	44	22	0,23	180	3.2.4
GMG 7 A	10,8	14,7	1450	59	29,5	0,33	230	4.2.3
GMG 8 A	14,4	19,6	1460	68	39	0,57	265	5.0.24
GMG 9 A	20,4	28	1460	109	54,5	0,95	310	6.0.11

D. C. shunt-wound motors for lifts

Design B 3

Protective system P 33, with commutating poles and compound winding

Standard voltages 220 or 440 volts

Type	Rated capacity kW	Rated capacity HP	Rated speed rpm.	Current input at 220 V abt. amp.	Current input at 440 V abt. amp.	Moment of inertia GD^2 kgm^2	Approx. net weight kg	Approx. net weight cwts.
Base speed 1000 rpm. 40 % ED								
GMG 2 A	0,9	1,22	920	6	3	0,036	70	1.1.14
GMG 3 A	1,4	1,9	920	9	4,5	0,043	80	1.2.8
GMG 4 A	1,9	2,6	930	11,8	5,9	0,13	100	1.3.24
GMG 5 A	2,5	3,4	930	15	7,5	0,175	130	2.2.6
GMG 6 A	2,4	4,6	940	20	10	0,23	180	3.2.4
GMG 7 A	4,8	6,5	940	27,8	14,1	0,33	230	4.2.3
GMG 8 A	6,5	8,9	950	36,5	18,3	0,57	260	5.0.24
GMG 9 A	9,2	12,5	950	51	25,5	0,95	310	6.0.11
GMG 10 A	12,5	17	960	68	34	2	320	6.1.5
GMG 11 A	17	22	960	93	46,5	2,3	460	9.0.17
GMG 12 A	23	31	960	124	62	4,1	590	11.2.19
GMG 13 A	29	41	960	158	79	5,2	750	14.3.1
GMG 14 A	37	50	970	193	96,5	8	850	16.2.26
GMG 15 A	46	62,5	970	240	120	9	(1100)	(21.2.17)
GMG 16 A	57	77,5	980	294	147	17	(1400)	(27.2.7)
GMG 17 A	70	95	980	360	180	10	(1600)	(31.2.2)
Base speed 1000 rpm. 25 % ED								
GMG 2 A	1,15	1,55	920	7,6	3,8	0,036	70	1.1.14
GMG 3 A	1,8	2,45	920	11,4	5,7	0,043	80	1.2.8
GMG 4 A	2,5	3,4	930	15,4	7,7	0,13	100	1.3.24
GMG 5 A	3,5	4,75	930	21	10,5	0,175	130	2.2.6
GMG 6 A	4,6	6,25	940	27	13,5	0,23	180	3.2.4
GMG 7 A	6,5	8,9	940	37,5	17,7	0,33	230	4.2.3
GMG 8 A	8,5	11,5	950	48,5	24,2	0,57	260	5.0.24
GMG 9 A	12	16,3	950	66,5	33,2	0,95	310	6.0.11
GMG 10 A	16	21,8	960	88	44	2	320	6.1.5
GMG 11 A	22	30	960	118	59	2,3	460	9.0.17
GMG 12 A	27,5	37,5	965	146	73	4,1	590	11.2.19
GMG 13 A	35	47,5	965	185	92,5	5,2	750	14.3.1
GMG 14 A	44,5	60,5	970	234	117	8	850	16.2.26
GMG 15 A	55	75	970	286	143	9	(1100)	(21.2.17)
GMG 16 A	68,5	92,5	980	356	178	17	(1400)	(27.2.7)
GMG 17 A	84	115	980	430	215	20	(1600)	(31.2.2)

( ) Calculated figures

D. C. shunt-wound motors for lifts

Design B 3

Protective system P 33, with commutating poles and compound winding

Standard voltages 220 or 440 volts

Type	Rated capacity kW	Rated capacity HP	Rated speed rpm.	Current input at 220 V abt. amp.	Current input at 440 V abt. amp	Moment of inertia GD^2 kgm^2	Approx. net weight kg	Approx. net weight cwts.
Base speed 750 rpm. 40% ED								
GMG 10 A	10	13,6	725	56	28	2	350	6.3.15
GMG 11 A	13,3	18	725	75	37,5	2,3	470	9 1.0
GMG 12 A	17	23	730	93	46,5	5,1	580	11.1.18
GMG 13 A	21,5	29	730	118	59	5,2	750	14.3.1
GMG 14 A	28	38	730	150	75	8	850	16.2.26
GMG 15 A	36	49	730	190	95	9	(1100)	(21.2.17)
GMG 16 A	44	60	735	236	113	17	(1400)	(27.2.7)
GMG 17 A	56	76	735	292	149	20	(1600)	(31.2.2)
GMG 18 A	68	92,5	735	354	177	23	(2200)	(43.0.0)
GMG 19 A	33	113	735	430	215	26	(2450)	(48.0.0)
Base speed 750 rpm. 25% ED								
GMG 10 A	12	16,3	725	67	33,5	2	350	6.3.15
GMG 11 A	16	21,8	725	88	44	2,3	470	9.1.0
GMG 12 A	20,5	28	730	112	56	4,1	580	11.1.18
GMG 13 A	26	35,5	730	140	70	5,2	750	14.3.1
GMG 14 A	33,5	45,5	730	180	90	8	850	16.2.26
GMG 15 A	53	58,5	730	228	114	9	(1100)	(21.2.17)
GMG 16 A	53	72	735	280	140	17	(1400)	(27.2.7)
GMG 17 A	67	91	735	350	175	20	(1600)	(31.2.2)
GMG 18 A	82	112	735	420	210	23	(2200)	(43.0.0)
GMG 19 A	100	236	735	505	252,5	26	(2450)	(48.0.0)

( ) Calculated figures

D. C. shunt-wound motors for lifts

Design B 3

Protective system P 33, with commutating poles and compound winding

Standard voltages 220 or 440 volts

Type	Rated capacity kW	Rated capacity HP	Rated speed rpm.	Current input at 220 V abt. amp.	Current input at 240 V abt. amp.	Moment of inertia GD^2 kgm^2	Approx. net weight kg	Approx. net weight cwts.
Base speed 600 rpm. 40% ED								
GMG 14 A	21	28,5	585	116	58	8	850	16.2.26
GMG 15 A	28	38	585	150	75	9	(1100)	(21.2.17)
GMG 16 A	36	49	585	192	96	17	(1400)	(27.2.7)
GMG 17 A	44	60	585	235	117	20	(1600)	(31.2.2)
GMG 18 A	55	75	585	290	145	23	(2200)	(43.0.0)
GMG 19 A	66	90	585	348	174	26	(2450)	(48.0.0)
Base speed 600 rpm 25% ED								
GMG 14 A	25	34	585	136	68	8	850	16.2 26
GMG 15 A	33,5	45,5	585	180	90	9	(1100)	(21.2 17)
GMG 16 A	43	58,5	585	230	115	17	(1400)	(27.2.7)
GMG 17 A	53	72	585	280	140	20	(1600)	(31.2.2)
GMG 18 A	66	90	585	346	173	23	(2200)	(43.0.0)
GMG 19 A	80	109	585	415	207,5	26	(2450)	(48.0.0)

( ) Calculated figures

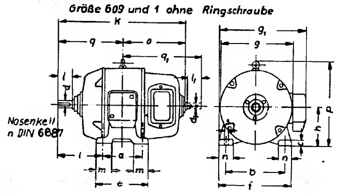
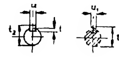


Abb. 1



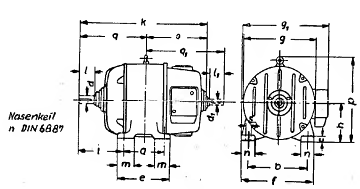


Abb. 2

Größe 609 = Size 609 and 1 without ring screw

Nosenkeil = Nose key according to DIN 6887

Size of design	a	b	c	e	f	g	g_1	h	i	k	m	n	o	p	q	s	Pict.
09	135	185	16	165	225	215	278	112	150,5	428	50	40	210	220	218	11,5	1
1	170	185	16	200	225	215	278	112	150	463	50	40	228	220	235	11,5	1
2	160	230	20	200	280	270	330	140	153	478	60	50	245	320	233	14	1
3	200	230	20	240	280	270	330	140	153	518	60	50	265	320	253	14	1
4	180	270	25	230	330	315	401	160	168	538	75	60	280	362	258	14	1
5	210	270	25	260	330	315	401	160	168	568	75	60	295	362	273	14	1
6	220	330	28	280	400	385	470	200	220	645	90	70	315	445	330	18	1
7	260	330	28	320	400	385	470	200	220	685	90	70	335	445	350	18	1
8	250	370	32	330	450	442	550	225	248	748	110	80	375	505	373	23	1
9	300	370	32	380	450	442	550	225	248	798	110	80	400	505	398	23	1
10	270	450	40	385	550	550	680	280	288	855	120	100	432	625	423	27	1
11	310	450	40	405	550	550	680	280	288	895	120	100	452	625	443	27	1
12	315	510	45	410	630	615	718	315	323	973	135	120	492	695	481	27	2
13	350	510	45	445	630	615	718	315	323	1008	135	120	509,5	695	498	27	2
14	380	580	50	475	705	695	787	355	360	1122		125	572	810	550	27	2
15	420	580	50	515	705	695	787	355	360	1162		125	592	810	570	27	2
16	390	650	55	500	790	780	890	400	405	1195		140	595	918	600	33	2
17	450	650	55	560	790	780	890	400	405	1255		140	625	918	630	33	2
18	410	710	60	520	870	850	965	450	430	1235		160	600	1000	535	33	2
19	470	710	60	580	870	850	965	450	430	1295		160	630	1000	665	38	2

Size of design	Shaft stump				Second shaft stump							
	d*)	l	$t_{-0,2}$	u	d_1*)	l_1	u_1	q_1 I	q_1 II	t_1	t_2	Pict.
09	18	50		6	14	30	5	245		16,1	20,5	1
1	18	50		6	14	30	5	263		16,1	20,5	1
2	22	60		6	18	40	6	290		20,5	24,5	1
3	22	60		6	18	40	6	310		20,5	24,5	1
4	28	75		8	22	50	6	335		24,5	31	1
5	28	75		8	22	50	6	350		24,5	31	1
6	38	95		10	28	60	8	380		30,9	41,5	1
7	38	95		10	28	60	8	400		3 ,9	41,5	1
8	45	110		14	38	80	10	465		41,3	49	1
9	45	110		14	38	80	10	490		41,3	49	1
10	55	130		16	45	110	14	552		48,5	60	1
11	55	130		16	45	110	14	572		48,5	60	1
12	65	160		18	55	110	16	612		58,8	70	2
13	65	160		18	55	110	16	629,5		58,8	70	2
14	75	180		20	65	140	18	722		69,2	81	2
15	75	180		20	65	140	18	742		69,2	81	2
16	80	200		24	75	140	20	740		79,6	87	2
17	80	200		24	75	140	20	770		79,6	87	2
18	90	220		24	85	170	22	790		90,5	97	2
19	90	220		24	85	170	22	820		90,5	97	2

*) Shaft stump according to DIN 42943 (German Board of Standards) page 1 with ISA-fit up to a diameter of 45 mm (obt. $1^3/_4$") K 6. more than 45 mm Ø m 6 according to DIN 7160   Sizes G 09 and 1 without ring screw.

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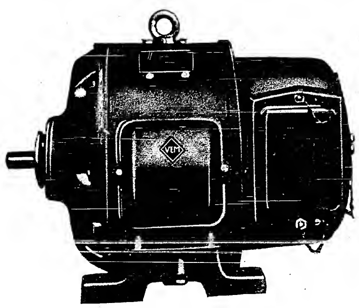


D.C. SHUNT-WOUND MOTORS

Design B 3

Protective system P 33

without surface-cooling,

with commutating poles and anti-friction bearing

D. C. shunt-wound motors

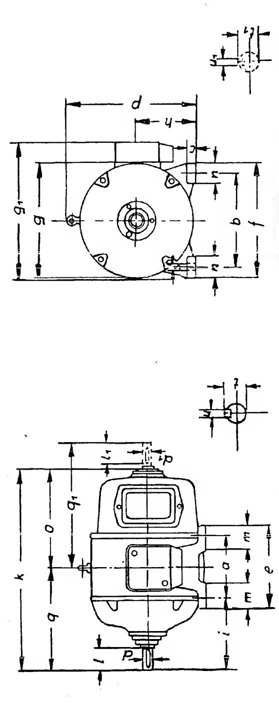
Design B 3

Protective system P 33, without surface-cooling, with commutating poles and anti-friction bearing

Type	Capacity kW	Approx. weight kg	Approx. weight cwts.	Capacity kW	Approx. weight kg	Approx. weight cwts.
No-load speed	for 3000 rpm.			for 1500 rpm.		
GMG 08	0,3	24	0.1.24	0,25	24	0.1.24
GMG 09	0,44	41	0.3.6	0,35	41	0.3.6
GMG 1	0,6	44	0.3.13	0,5	44	0.3.13
GMG 2	0,9	70	1.1.14	0,74	70	1.1.14
GMG 3	1,25	80	1.2.8	1,05	80	1.2.8
GMG 4	1,5*	100	1.3.24	1,2	100	1.3.24
GMG 5	1,8*	130	2.2.6	1,5*	130	2.2.6
GMG 6	2,8*	180	3.2.4	2,3*	180	3.2.4
GMG 7	3,7*	230	4.2.3	3*	230	4.2.3
GMG 8	4,7*	265	5.0.24	3,8	275	5.0.24
GMG 9	6*	310	6.0.11	5*	310	6.0.11
No-load speed	for 1000 rpm.			for 750 rpm.		
GMG 08	0,19	24	0.1.24	—	—	—
GMG 09	0,26	41	0.3.6	0,21	41	0.3.6
GMG 1	0,37	44	0.3.13	0,31	44	0.3.13
GMG 2	0,55	70	1.1.14	0,45	70	1.1.14
GMG 3	0,76	80	1.2.8	0,66	80	1.2.8
GMG 4	0,92	100	1.3.24	0,75	100	1.3.24
GMG 5	1,15*	130	2.2.6	0,91	130	2.2.6
GMG 6	1,74*	180	3.2.4	1,48	180	3.2.4
GMG 7	2,26*	230	4.2.3	1,9*	230	4.2.3
GMG 8	2,95*	265	5.0.24	2,4*	265	5.0.24
GMG 9	4*	310	6.0.11	3,3*	310	6.0.11

Rated voltages 110, 220, 440 volts.

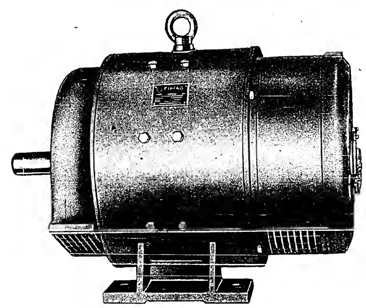
*) Compound winding necessary.



Type GMG	a	b	c	e	f	g	g1	h2)	i	k	m	n	o	p	g	s	Shaft stump d1)	l	t-0,2	u	Second shaft stump d1 1)	l1	u1	q1 I	q1 II	t1
07 08	115 140	140	12	140 165	175	172	218	90	95	298 323	40	35	146 158	176	152 165	9,5	14	30	16,1	5	14	30	5	178 190		16,1
09 1	135 170	185	16	165 200	225	215	278	112	140,5	418 453	50	40	210 228	220	208 225	11,5	18	40	20,5	6	14	40	5	245 263		16'1
2 3	160 200	230	20	200 240	280	270	330	140	143	468 508	60	50	245 265	320	223 243	14	22	50	24'5	6	18	50	6	240 310		20,5
4 5	180 210	270	25	230 260	330	315	401	160	143	513 543	75	60	280 295	362	233 248	14	22	50	24,5	6	22	50	6	335 350		24,5
6 7	220 260	330	28	280 320	400	385	470	200	189	610 650	90	70	315 335	445	295 315	18	28	60	30,9	8	28	60	8	380 400		30,9
8 9	250 300	370	32	330 380	450	442	550	225	198	698 748	110	80	375 400	505	323 358	23	28	60	30,9	8	28	60	8	445 470		30,9
10 11	270 310	450	40	355 405	550	550	680	280	328	805 845	120	100	432 452	625	373 398	27	38	80	41,3	10	38	80	10	522 542		41,3

1) Shaft ends according to DIN 42943 page 1 with ISA fit k6

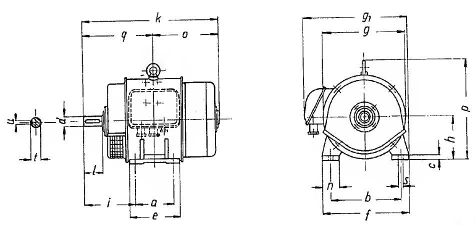
Size 07–1 without ring screw



FIMAG D.C. GENERATORS, TYPE GGB

These types of generators can be delivered as shunt or as compound machines.

The are equipped with antifriction bearings with grease lubrication.

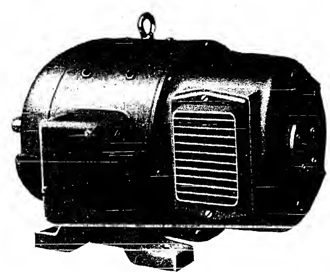


Type	a	b	c	e	f	g	g_1	h	i	k
GGB 24–266	245	410	22	310	500	480	605	250	295	810 mm
GCB 12–230	220	290	13	265	350	406	500	225	245	674 mm
GGB 6–170										

Type	n	o	p	q	s	d	l	t	u
GGB 24–266	90	392,5	575	417,5	25	55	110	58,8	16 mm
GGB 12–230	60	340	490	334	20	42	110	45,1	12 mm
GGB 6–170									

Design: B 3
System of operation: Continuous service (DB)
Ventilation: Self-cooling
Insulation classification: "A" according to VDE 0530

Type	kW	V	amp.	rpm.	η %	Protective system	Approx. weight kg	cwts.
GGB 24–266	24	115 230	208 104	1500	85,5 86	P 12	355	7.0.0
GGB 6–170	6	115 230	52 26	1500		d 12		
GGB 12–230	12	115 230	104 52	1500		P 11	225	4.2.0



D.C. SHUNT GENERATORS

Design B 3 Protective system P 20, P 21 or P 22,

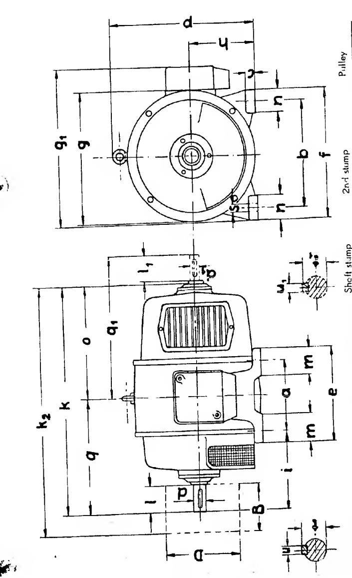
with commutating poles, antifriction bearing

D. C. Shunt Generators

Design B 3   Protective system P 20, P 21 or P 22 with commutating poles, antifriction bearing.

Type	Power kW	Driving power abt. HP	Nominal speed rpm.	Current consumption at 115 volts abt. amps.	230 volts abt. amps.	460 volts abt. amps.	Approx. weight kg	cwts.
No-load speed 3000 rpm. Design I								
GGB 07	0,35	0,78	2760	3,04	1,52	0,76	19	0.1.13
GGB 08	0,6	1,15	2780	5,2	2,6	1,3	22	0.1.20
GGB 09	1,1	2	2800	9,6	4,8	2,4	39	0.3.2
CGB 1	1,8	3,2	2820	15,6	7,8	3,9	42	0.3.8
GGB 2	3	5,2	2840	26	13	6,5	66	1.1.5
GGB 3	4,5	7,6	2850	39	19,5	9,7	80	1.2.8
GGB 4	7	11,5	2860	61	30,5	15,25	94	1.3.11
GGB 5	10	16,2	2870	87	43,5	21,75	109	2.0.17
GGB 6	14	22,5	2875	122*)	61	30,5	160	3.0.17
GGB 7	20	31,8	2880	173*)	87	43,5	190	3.3.0
GGB 8	28	44	2900	—	122	61	265	5.0.24
GGB 9	38	60,1	2900	—	165*)	92,5	303	5.3.23
No-load speed 1500 rpm. Design I								
GGB 07	0,15	0,32	1400	1,3	0,65	0,33	19	0.1.13
GGB 08	0,25	0,58	1400	2,16	1,08	0,54	22	0.1.20
GGB 09	0,5	0,73	1400	4,35	2,17	1,08	39	0.3.2
GGB 1	0,8	1,48	1410	6,95	3,48	1,74	42	0.3.8
GGe 2	1,4	2,5	1420	12,2	6,1	3,05	66	1.1.5
GGB 3	2,2	3,85	1430	19,2	9,6	4,8	80	1.2.8
GGB 4	3,5	5,95	1440	30,4	15,2	7,6	94	1.3.11
GGB 5	5	8,4	1440	43,6	21,8	10,9	109	2.0.17
GGB 6	7	11,6	1450	61	30,5	15,3	160	3.0.17
GGB 7	10	16,4	1450	87	43,5	21,8	190	3.3.0
GGB 8	14	22,5	1460	122	61	30,5	265	5.0.24
GGB 9	20	32,2	1460	174*)	87	43,5	303	5.3.23
GGB 10	28	44,4	1460	244*)	122	61	315	6.0.22
GGB 11	38	60	1460	330*)	165	82,5	457	9.0.0
GGB 12	50	78	1465	435*)	217	108	580	11.1.18
GGB 13	63	97,5	1465	—	274	137	(700)	(13.3.0)
GGB 14	80	123	1470	—	348	174	(850)	(16.2.26)
GGB 15	100	153	1470	—	435*)	217	(1000)	(21.2.17)
GGB 16	125	190	1475	—	545*)	272	(1100)	(22.0.0)
GGB 17	160	242	1475	—	695*)	347	(1500)	(29.0.0)
GGB 18	200	200	1480	—	870*)	435*)	(1600)	(31.0.0)
GGB 19	250	375	1480	—	1090*)	545*)	(2000)	(40.0.0)

*) Design II according to measuring drawing Mb 3194, all other generators are delivered according to Design I. Generators of protective system P 33 on request. Standard voltages 115, 230, 460 volts. () Calculated values.



1. Shaft stump according to DIN 42 943 sheet 1 with ISA fitting up to 45 ∅ k6 more than 45 ∅ m 6
2. Measurements: up to 250 = −0,5 mm more than 250 = −1 mm DIN 747
3. Pulleys according to DIN 42 943; sizes 07—1 have no ring-screw.

The letters refer to the drawings: sizes in mm

Typ GGB	a	b	c	e	f	g	g_1 max	h 2)	i	k* I	k* II	m	n	o* I	o* II	p	q	s
07	115*	140	12	140	175	172	213	90	95	298	—	40	35	146	—	176	152	9,5
08	140*	140	12	165	175	172	218	90	95	323	—	40	35	158	—	176	165	9,5
09	135	185	16	165	225	215	278	112	140,5	418	—	50	40	210	—	220	208	11,5
1	170	185	16	200	225	215	278	112	140,5	453	—	50	40	228	—	220	225	11,5
2	160	230	20	200	280	270	330	140	170	495	—	60	50	245	—	320	250	14
3	200	230	20	240	280	270	330	140	170	535	—	60	50	265	—	320	270	14
4	180	270	25	230	330	315	401	160	195	565	—	75	60	280	—	362	285	14
5	210	270	25	260	330	315	401	100	195	595	—	75	60	295	—	362	300	14
6	220	330	28	280	400	385	470	200	240	665	694	90	70	315	344	445	350	18
7	260	330	28	320	400	385	470	200	240	705	734	90	70	335	364	445	370	18
8	250	370	32	330	450	442	550	225	293	793	856	110	80	375	437	505	418	23
9	300	370	32	380	450	442	550	225	293	843	905	110	80	400	462	505	443	23
10	270	450	40	365	550	550	680	280	315	882	945	120	100	432	495	625	450	27
11	310	450	40	405	550	550	680	280	315	922	985	120	100	452	515	625	470	27

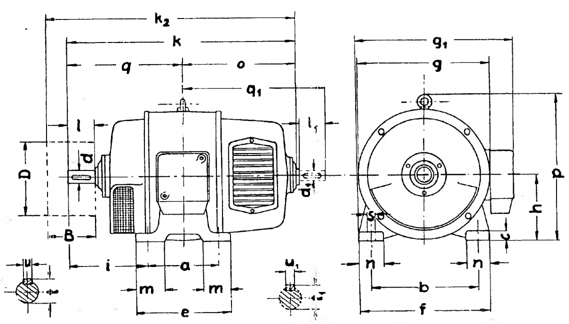
Typ GGB	Wellenstumpf d 1)	l	t −0,2	u	2ter Stumpf d_1 1)	l_1	u_1	t_1 −0,2	q_1* I	q_1* II	Riemenscheibe D 3)	B	k_2* I	k_2* II
07	14	30	16,1	5	14	30	5	16,1	178	—	50	50	318	—
08	14	30	16,1	5	14	30	5	16,1	190	—	63	50	343	—
09	18	40	20,5	6	14	30	5	16,1	245	—	80	60	438	—
1	18	40	20,5	6	14	30	5	16,1	263	—	100	60	473	—
2	22	50	24,5	6	18	40	6	20,5	290	—	125	85	530	—
3	22	50	24,5	6	18	40	6	20,5	310	—	160	85	570	—
4	28	60	30,9	8	22	50	6	24,5	335	—	160	100	605	—
5	28	60	30,9	8	22	50	6	24,5	350	—	200*	100	635	—
6	38	80	41,3	10	28	60	8	30,9	380	409	200*	120	705	734
7	38	80	41,3	10	28	60	8	30,9	400	429	250*	120	757	774
8	45	110	48,5	14	38	80	10	41,3	465	527	250*	140	823	870
9	45	110	48,5	14	38	80	10	41,3	490	552	320*	170	913	935
10	55	110	58,5	16	45	110	14	48,5	552	615	320*	200	982	1005
11	55	110	58,5	16	45	110	14	48,5	572	635	360*	200	1022	1045

D. C. Shunt Generators

Design B 3 Protective system P 20, P 21 or P 22 with commutating poles, antifriction bearing.

Type	Power kW	Driving power abt. HP	Nominal speed rpm.	Current consumption at 115 volts abt. amps.	230 volts abt. amps.	460 volts abt. amps.	Approx. weight kg	cwts.
			No-load speed 3000 rpm.	Design I				
GGB 07	0,35	0,78	2760	3,04	1,52	0,76	19	0.1.13
GGB 08	0,6	1,15	2780	5,2	2,6	1,3	22	0.1.20
GGB 09	1,1	2	2800	9,6	4,8	2,4	39	0.3.2
CGB 1	1,8	3,2	2820	15,6	7,8	3,9	42	0.3.8
GGB 2	3	5,2	2840	26	13	6,5	66	1.1.5
GGB 3	4,5	7,6	2850	39	19,5	9,7	80	1.2.8
GGB 4	7	11,5	2860	61	30,5	15,25	94	1.3.11
GGB 5	10	16,2	2870	87	43,5	21,75	109	2.0.17
GGB 6	14	22,5	2875	122*)	61	30,5	160	3.0.17
GGB 7	20	31,8	2880	173*)	87	43,5	190	3.3.0
GGB 8	28	44	2900	—	122	61	265	5.0.24
GGB 9	38	60,1	2900	—	165*)	92,5	303	5.3.23
			No-load speed 1500 rpm.	Design I				
GGB 07	0,15	0,32	1400	1,3	0,65	0,33	19	0.1.13
GGB 08	0,25	0,58	1400	2,16	1,08	0,54	22	0.1.20
GGB 09	0,5	0,73	1400	4,35	2,17	1,08	39	0.3.2
GGB 1	0,8	1,48	1410	6,95	3,48	1,74	42	0.3.8
GGe 2	1,4	2,5	1420	12,2	6,1	3,05	66	1.1.5
GGB 3	2,2	3,85	1430	19,2	9,6	4,8	80	1.2.8
GGB 4	3,5	5,95	1440	30,4	15,2	7,6	94	1.3.11
GGB 5	5	8,4	1440	43,6	21,8	10,9	109	2.0.17
GGB 6	7	11,6	1450	61	30,5	15,3	160	3.0.17
GGB 7	10	16,4	1450	87	43,5	21,8	190	3.3.0
GGB 8	14	22,5	1460	122	61	30,5	265	5.0.24
GGB 9	20	32,2	1460	174*)	87	43,5	303	5.3.23
GGB 10	28	44,4	1460	244*)	122	61	315	6.0.22
GGB 11	38	60	1460	330*)	165	82,5	457	9.0.0
GGB 12	50	78	1465	435*)	217	108	580	11.1.18
GGB 13	63	97,5	1465	—	274	137	(700)	(13.3.0)
GGB 14	80	123	1470	—	348	174	(850)	(16.2.26)
GGB 15	100	153	1470	—	435*)	217	(1000)	(21.2.17)
GGB 16	125	190	1475	—	545*)	272	(1100)	(22.0.0)
GGB 17	160	242	1475	—	695*)	347	(1500)	(29.0.0)
GGB 18	200	200	1480	—	870*)	435*)	(1600)	(31.0.0)
GGB 19	250	375	1480	—	1090*)	545*)	(2000)	(40.0.0)

*) Design II according to measuring drawing Mb 3194, all other generators are delivered according to Design I. Generators of protective system P 33 on request. Standard voltages 115, 230, 460 volts. () Calculated values.

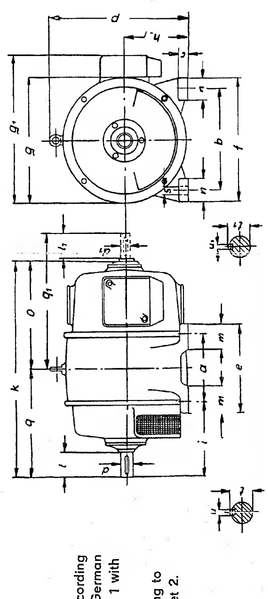


1. Shaft stump according to DIN 42 943 sheet 1 with ISA fitting up to 45 ∅ k6 more than 45 ∅ m 6
2. Measurements: up to 250 = −0,5 mm more than 250 = −1 mm DIN 747
3. Pulleys according to DIN 42 943: sizes 07—1 have no ring-screw.

The letters refer to the drawings: sizes in mm

Typ GGB	a	b	c	e	f	g	g_1 max	h 3)	i	k* I	k* II	m	n	o* I	o* II	p	q	s
07	115*	140	12	140	175	172	218	90	95	298	—	40	35	146	—	176	152	9,5
08	140*	140	12	165	175	172	218	90	95	323	—	40	35	158	—	176	165	9,5
09	135	185	16	165	225	215	278	112	140,5	418	—	50	40	210	—	220	208	11,5
1	170	185	16	200	225	215	278	112	140,5	453	—	50	40	228	—	220	225	11,5
2	160	230	20	200	280	270	330	140	170	495	—	60	50	245	—	320	250	14
3	200	230	20	240	280	270	330	140	170	535	—	60	50	265	—	320	270	14
4	180	270	25	230	330	315	401	160	195	565	—	75	60	280	—	362	285	14
5	210	270	25	260	330	315	401	160	195	595	—	75	60	295	—	362	300	14
6	220	330	28	280	400	385	470	200	240	665	694	90	70	315	344	445	350	18
7	260	330	28	320	400	385	470	200	240	705	734	90	70	335	364	445	370	18
8	250	370	32	330	450	442	550	225	293	793	856	110	80	375	437	505	418	23
9	300	370	32	380	450	442	550	225	293	843	905	110	80	400	462	505	443	23
10	270	450	40	365	550	550	680	280	315	882	945	120	100	432	495	625	450	27
11	310	450	40	405	550	550	680	280	315	922	985	120	100	452	515	625	470	27

Typ GGB	Wellenstumpf (Shaft stump) d 1)	l	t −0,2	u	2ter Stumpf (2nd stump) d_1 1)	l_1	u_1	t_1 −0,2	q_1* I	q_1* II	Riemenscheibe (Pulley) D 3)	B	k_2* I	k_2* II
07	14	30	16,1	5	14	30	5	16,1	178	—	50	50	318	—
08	14	30	16,1	5	14	30	5	16,1	190	—	63	50	343	—
09	18	40	20,5	6	14	30	5	16,1	245	—	80	60	438	—
1	18	40	20,5	6	14	30	5	16,1	263	—	100	60	473	—
2	22	50	24,5	6	18	40	6	20,5	290	—	125	85	530	—
3	22	50	24,5	6	18	40	6	20,5	310	—	160	85	570	—
4	28	60	30,9	8	22	50	6	24,5	335	—	160	100	605	—
5	28	60	30,9	8	22	50	6	24,5	350	—	200*	100	635	—
6	38	80	41,3	10	28	60	8	30,9	380	409	200*	120	705	734
7	38	80	41,3	10	28	60	8	30,9	400	429	250*	120	757	774
8	45	110	48,5	14	38	80	10	41,3	465	527	250*	140	823	870
9	45	110	48,5	14	38	80	10	41,3	490	552	320*	170	913	935
10	55	110	58,5	16	45	110	14	48,5	552	615	320*	200	982	1005
11	55	110	58,5	16	45	110	14	48,5	572	635	360*	200	1022	1045



1. Shaft stump according to DIN 42 943 (German Standard) sheet 1 with ISA fitting, 6 m.
2. Pulleys according to DIN 42 943 sheet 2.

Mb 3194

The letters refer to the drawings: sizes In mm

Typ GGB	a	b	c	e	f	g	g_1	h	i	k I	k II	m	n	o I	o II
12	315	510	45	410	630	615	717,5	315	363,5	1013	1075	135	120	492	554
13	350	510	45	445	630	615	717,5	315	363,5	1048	1110	135	120	509,5	571,5
14	380	580	50	475	705	695	787	355	360	1122	1182	—	125	572	632
15	420	580	50	515	705	695	787	355	360	1162	1222	—	125	592	652
16	390	650	55	500	790	780	890	400	380	1170	1290	—	140	595	715
17	450	650	55	560	790	780	890	400	380	1230	1350	—	140	625	745
18	410	710	60	520	870	850	965	450	395	1200	1320	—	160	600	720
19	470	710	60	580	870	850	965	450	395	1260	1380	—	160	630	750

Typ GGB	p	q	s	Shaft stump / Wellenstumpf d	l	t -0,2	u	2nd stump / Zweiter Stumpf d_1	l_1	t_1 -0,2	u_1	q_1 I	q_1 II
12	695	521	27	65	140	69,2	18	55	110	58,8	16	612	674
13	695	538,5	27	65	140	69,2	18	55	110	58,8	16	629,5	691,5
14	810	550	27	75	140	79,6	20	65	140	69,2	18	722	782
15	810	570	27	75	140	79,6	20	65	140	69,2	18	742	802
16	918	575	33	85	170	90,5	22	75	140	79,6	20	740	860
17	918	605	33	85	170	90,5	22	75	140	79,6	20	770	890
18	1000	600	33	95	170	100,5	25	85	170	90,5	22	790	910
19	1000	630	33	95	170	100,5	25	85	170	95,5	22	820	940

D. C. Shunt Generators

Design B 3 Protective system P 20, P 21 or P 22 with commutating poles, antifriction bearing.

Type	Power kW	Driving power abt. HP	Nominal speed rpm.	Current consumption at 115 volts abt. amps.	230 volts abt. amps.	460 volts abt. amps.	Approx. weight kg	cwts.
No-load speed 1000 rpm. Design I								
GGB 2	0,75	1,6	920	6,5	3,25	1,63	66	1.1.5
GGB 3	1,2	2,3	920	10,5	5,25	2,63	80	1.2.8
GGB 4	1,8	3,4	930	15,7	7,8	3,9	94	1.3.11
GGB 5	2,6	4,7	930	22,6	11,3	5,65	107	2 0.13
GGB 6	3,8	6,7	940	33	16,5	8,25	160	3.0.17
GGB 7	5,5	9,5	940	48	24,	12	190	3.3.0
GGB 8	7 5	12,7	950	65	32,5	16,25	265	5.0.24
GGB 9	11	18,2	950	96	48	24	303	5.3 23
GGB 10	16	26	960	140	70	35	315	6.0.22
GGB 11	22	35,4	960	192	96	48	457	9.0 0
GGB 12	30	48	965	260	130	65	580	11.1.18
GGB 13	38	59	965	330*)	165	82,5	(700)	(13.3 0)
GGB 14	50	76,5	970	435*)	217	108	(850)	(16.2.26)
GGB 15	63	96	970	548*)	274	137	(1000)	(21.2.17)
GGB 16	80	121	980	696*)	348	174	(1100)	(22.0 0)
GGB 17	100	150	980	—	435*)	217	(1500)	(29 0.0)
GGB 18	125	188	985	—	545*)	272	(1600)	(31.0.0)
GGB 19	160	240	985	—	695*)	347	(2000)	(40.0.0)
No-load speed 750 rpm. Design I								
GGB 4	1,2	2,4	710	10,4	5,2	2,6	94	1.3.11
GGB 5	1,8	3,4	710	15,7	7,8	3,9	109	2.0.17
GGB 6	2,6	4,7	715	22,6	11,3	5,65	190	3.0.17
GGB 7	3,8	6,7	715	33	16,5	8,75	190	3.3.0
GGB 8	5,5	9,5	720	48	24	12	265	5.0.24
GGB 9	7,5	12,7	720	65	32,5	16,3	303	5.3.23
GGB 10	11,5	19,2	725	100	50	25	315	6.0.22
GGB 11	16	26,2	725	140	70	35	457	9.0.0
GGB 12	21,5	35	730	188	94	47	580	11.1.18
GGB 13	28	45	730	244	122	61	(700)	(13.3.0)
GGB 14	38	60	730	330	165	82,5	(850)	(16.2 26)
GGB 15	50	79,2	730	435*)	217	108	(1000)	(21.2.17)
GGB 16	63	98	735	548*)	274	137	(1100)	(22.0.0)
GGB 17	80	124	735	696*)	348	174	(1500)	(29 0.0)
GGB 18	100	153	735	870*)	435	217	(1600)	(31.0.0)
GGB 19	125	190	735	1090*)	545*)	272	(2000)	(40.0.0)

*) Design II according to measuring drawing Mb 3194, all other generators are delivered according to Design I. Generators of protective system P 33 on request. Standard voltages 115, 230, 460 volts () Calculated values

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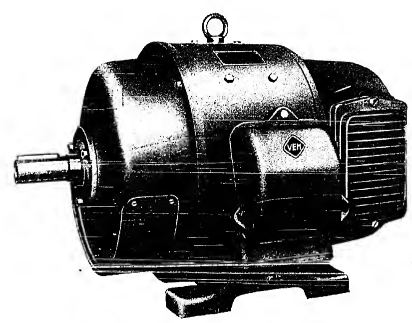

D.C. GENERATORS

for floating equipments

Design B 3

Protective system P 21/22

The generators correspond to the "Regulations for assessment and testing of electric engines" VDE 0530 (REM) respectively to the prescriptions of the DSRK (Deutsche Schiffs-Revision und Klassifikation).

D. C. Generators for floating equipments

Design B 3 Protective system P 21/22

Type	Power kW	Efficiency about %	Power input abt. kW	Power input abt HP	Nominal speed rpm.	Approx. weight kg	Approx. weight cwts.
Lost motion speed 3000 rpm.							
GGB 07	0,32	69	0,46	0,63	2800	17	0.1.9
GGB 08	0,5	71,5	0,70	0,95	2800	20	0.1.16
GGB 09	0,8	74	1,08	1,47	2820	35	0.2.21
GGB 1	1,4	76,5	1,83	2,49	2820	40	0.3.4
GGB 2	2,3	78,5	2,93	3,98	2820	52	1 0.2
GGB 3	3,6	80,5	4,48	6,1	2850	65	1.1.3
GGB 4	5,2	81,5	6,4	8,7	2850	95	1.3.13
GGB 5	7,6	83	9,2	12,5	2850	120	2.1.13
GGB 6	11	84	13,1	17,8	2880	170	3.1.11
GGB 7*)	17	85	20	27,2	2880	190	3.3.0
GGB 8*)	24	86	28	38	2900	215	4.0.26
GGB 9*)	35	87	40	54,4	2900	240	4.2.25
GGB 10	—	—	—	—	—	315	6.0.22
GGB 11	—	—	—	—	—	475	9.1.11
GGB 12	—	—	—	—	—	530	10.1.20
GGB 13	—	—	—	—	—	720	14.0.22
GGB 14	—	—	—	—	—	900	17.2.24
GGB 15	—	—	—	—	—	1100	22.0.0
GGB 16	—	—	—	—	—	1400	27.0.0
GGB 17	—	—	—	—	—	1600	31.0.0
GGB 18	—	—	—	—	—	2200	43.0.0
GGB 19	—	—	—	—	—	2500	49.0.0

*) For 230/460 volts only

Standard voltages 115, 230, 460 volts

For 115 volts the efficiency is 1% lower.

D. C. Generators for floating equipments

Design B 3 Protective system P 21/22

Type	Power kW	Efficiency about %	Power input abt. kW	Power input abt. HP	Nominal speed rpm.	Approx. weight kg	Approx. weight cwts.
Lost motion speed 1500 rpm.							
GGB 07	0,13	63	0,21	0,28	1400	17	0.1.9
GGB 08	0,22	66,5	0,33	0,45	1400	20	0.1.16
GGB 09	0,38	69,5	0,55	0,75	1400	35	0.2.21
GGB 1	0,65	72,5	0,90	1,22	1410	40	0.3.4
GGB 2	1,1	75	1,47	2	1410	52	1.0.2
GGB 3	1,8	77,5	2,3	3,1	1420	65	1.1.3
GGB 4	2,6	79	3,3	4,5	1420	95	1.3.13
GGB 5	3,8	80,5	4,7	6,4	1430	120	2.1.13
GGB 6	5,5	82	6,7	9,1	1430	170	3.1.11
GGB 7	8,5	83,5	10,2	13,8	1440	190	3.3.0
GGB 8	12	84,5	14,2	19,3	1440	215	4.0.26
GGB 9	18	85,5	21	28	1440	240	4.2.25
GGB 10	26	86,5	30	41	1450	315	6.0.22
GGB 11	35	87,5	40	54	1450	475	9.1.11
GGB 12	46	88,5	52	71	1460	530	10.1.20
GGB 13	59	89	66	90	1460	720	14.0.22
GGB 14*)	75	89,5	84	114	1460	900	17.2.24
GGB 15*)	94	90	104	141	1460	1100	22.0.0
GGB 16*)	116	90,5	128	174	1470	1400	27.0.0
GGB 17*)	150	91	165	224	1470	1600	31.0.0
GGB 18**)	190	91,5	208	282	1470	2200	43.0.0
GGB 19**)	235	91,5	257	349	1470	2500	49.0.0

*) For 230/460 volts only

**) For 460 volts only

Standard voltages 115, 230, 460 volts.

For 115 volts the efficiency is 1% lower.

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D. C. Generators for floating equipments
Design B 3 Protective system P 21/22

Type	Power	Efficiency	Power input		Nominol speed	Approx. weight	
	kW	about %	abt. kW	abt. HP	rpm.	kg	cwts.
Lost motion speed 1000 rpm.							
GGB 07						17	0.1.9
GGB 08						20	0.1.16
GGB 09						35	0.2.21
GGB 1						40	0.3.4
GGB 2	0,65	69,5	0,94	1,27	930	52	1.0.2
GGB 3	1,1	72,5	1,5	2,04	940	65	1.1.3
GGB 4	1,6	74	2,2	3	940	95	1.3.13
GGB 5	2,3	76,5	3	4,1	940	120	2.1.13
GGB 6	3,4	78,5	4,3	5,9	950	170	3.1.11
GGB 7	5	80	6,25	8,5	950	190	3.3.0
GGB 8	7,5	82	9,2	12,5	950	215	4.0.26
GGB 9	11	83,5	13,2	17,9	950	240	4.2.25
GGB 10	16	85	18,8	25,5	960	315	6.0.22
GGB 11	22	86	25,6	34,8	960	475	9.1.11
GGB 12	29	87	33,4	45,4	960	530	10.1.20
GGB 13	37	88	42	57	960	720	14.0.22
GGB 14*)	48	88,5	54,2	74	970	900	17.2.24
GGB 15*)	60	89,5	67	91	970	1100	22.0.0
GGB 16*)	77	90	86	117	970	1400	27.0.0
GGB 17*)	98	90,5	108	147	970	1600	31.0.0
GGB 18*)	123	91	135	184	980	2200	43.0.0
GGB 19*)	154	91	169	230	980	2500	49.0.0

*) For 230/460 volts only
Standard voltages 115, 230, 460 volts.

For 115 volts the efficiency is 1% lower.

D. C. Generators for floating equipments
Design B 3 Protective system P 21/22

Type	Power	Efficiency	Power input		Nominal speed	Approx. weight	
	kW	obout %	abt. kW	obt. HP	rpm.	kg	cwts.
Lost motion sped 750 rpm.							
GGB 07	—	—	—	—	—	17	0.1.9
GGB 08	—	—	—	—	—	20	0.1.16
GGB 09	—	—	—	—	—	35	0.2.21
GGB 1	—	—	—	—	—	40	0.3.4
GGB 2	—	—	—	—	—	52	1.0.2
GGB 3	—	—	—	—	—	65	1.1.13
GGB 4	1	71,5	1,4	1,9	700	95	1.3.13
GGB 5	1,5	73	2,1	2,9	700	120	2.1.13
GGB 6	2,3	75,5	3,1	4,2	700	170	3.1.11
GGB 7	3,4	77,5	4,4	6	700	190	3.3.0
GGB 8	5,4	79,5	6,8	9,3	710	215	4.0.26
GGB 9	7,8	81	9,6	13,1	710	240	4.2.25
GGB 10	11	82,5	13,4	18,2	710	315	6.0.22
GGB 11	16	84	19,1	26	710	475	9.1.11
GGB 12	21	85	24,7	33,6	720	530	10.1.20
GGB 13	27	86	31,4	43	720	720	14.0.22
GGB 14	35	87	40,3	55	720	900	17.2.24
GGB 15	44	88	50	68	720	1100	22.0.0
GGB 16	56	88,5	63,7	87	730	1400	27.0.0
GGB 17	72	89	81	110	730	1600	31.0.0
GGB 18*)	90	90	100	136	730	2200	43.0.0
GGB 19*)	113	90,5	125	170	730	2500	49.0.0

*) For 230/460 volts only
Standard voltages 115, 230, 460 volts.
For 115 volts the efficiency is 1% lower.

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D. C. Generators for floating equipments

Design B 3 Protective system P 21/22

Type	Power kW	Efficiency about %	Power input abt. kW	Power input abt. HP	Nominal speed rpm.	Approx. weight kg	Approx. weight cwts.
Lost motion speed 600 rpm.							
GGB 07	—	—	—	—	—	17	0.1.9
GGB 08	—	—	—	—	—	20	0.1.16
GGB 09	—	—	—	—	—	35	0.2.21
GGB 1	—	—	—	—	—	40	0.3.4
GGB 2	—	—	—	—	—	52	1.0.2
GGB 3	—	—	—	—	—	65	1.1.3
GGB 4	—	—	—	—	—	95	1.3.13
GGB 5	—	—	—	—	—	120	2.1.13
GGB 6	1,6	71	2,25	3,1	550	170	3.1.11
GGB 7	2,4	73,5	3,27	4,5	550	190	3.3.0
GGB 8	3,8	76	5	6,8	550	215	4.0.26
GGB 9	5,6	78	7,2	9,8	550	240	4.2.25
GGB 10	8,5	80,5	10,6	14	560	315	6.0.22
GGB 11	12	82	14,6	20	560	475	9.1.11
GGB 12	16	83,5	19,2	26	560	530	10.1.20
GGB 13	20	84,5	23,7	32	560	720	14.0.22
GGB 14	27	86	31,4	42,7	570	900	17.2.24
GGB 15	34	87	39	53	570	1100	22.0.0
GGB 16	43	87,5	49	67	570	1400	27.0.0
GGB 17	55	88,5	62	83	570	1600	31 0.0
GGB 18	70	89	79	107	580	2200	43.0.0
GGB 19	87	89,5	97	132	580	2500	49.0.0

Standard voltages 115, 230, 460 volts.
For 115 volts the efficiency is 1% lower.

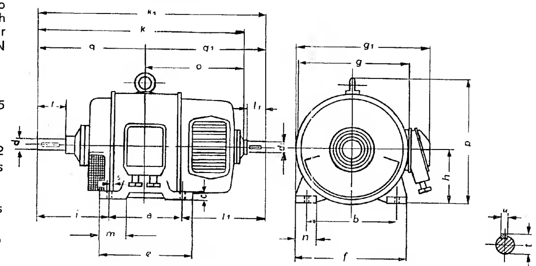
D. C. Generators for floating equipments

Design B 3 Protective system P 21/22

Type	Power kW	Efficiency about %	Power input abt. kW	Power input abt. HP	Nominal speed rpm.	Approx. weight kg	Approx. weight cwts.
Lost motion speed 500 rpm.							
GGB 07	—	—	—	—	—	17	0.1.9
GGB 08	—	—	—	—	—	20	0.1.16
GGB 09	—	—	—	—	—	35	0.2.21
GGB 1	—	—	—	—	—	40	0.3.4
GGB 2	—	—	—	—	—	52	1.0.2
GGB 3	—	—	—	—	—	65	1.1.3
GGB 4	—	—	—	—	—	95	1.3.13
GGB 5	—	—	—	—	—	120	2.1.13
GGB 6	1	66	1,52	2,07	460	170	3.1.11
GGB 7	1,6	69	2,32	3,15	460	190	3.3.0
GGB 8	2,6	72	3,61	4,9	460	215	4.0.26
GGB 9	3,8	74	5,14	7	460	240	4.2.25
GGB 10	6	77	7,8	10,6	460	315	6.0.22
GGB 11	8,2	79	10,4	14,1	470	475	9 1.11
GGB 12	12	81	14,8	20,2	470	530	10.1.20
GGB 13	15	82	18,3	25	470	720	14.0.22
GGB 14	20	83,5	24	32,6	470	920	17.2.24
GGB 15	26	84,5	30,8	42	470	1100	22.0.0
GGB 16	33	85,5	36,6	52,2	480	1400	27.0.0
GGB 17	43	86,5	50	68	480	1600	31.0.0
GGB 18	54	87,5	62	84	480	2200	43.0.0
GGB 19	67	88	76	103	480	2500	49.0.0

For 115 volts the efficiency is 1% lower.
Standard voltages 115, 230, 460 volts.

1. Shaft stump according to DIN 42 943 sheet 1 with ISA fitting k 6; register spring according to DIN 6885, design A.
2. **Tolerance of the axle height (h):**
   up to 250 = − 0,5
   more than 250 = − 1
3. Pulleys according to DIN 42 943 sheet 2
4. Column I: Measurements valuable for 230 and 660 volts
   Column II: Measurements valuable for 115 volts.
5. The sizes 07 − 1 have no ring screws.



Type GMB 0–11　　Shaft end　　Second shaft end

Typ GMB	a	b	c	e	f	g	g_1	h	i	k 1)	k 2)	m	n	o 1)	o 2)	p	q	s	Wellenende d	l	t	u	Zweites Wellenende 4) d_1	i_1	k_1 1)	k_1 2)	l_1	q_1 1)	q_1 2)	t_1	u_1
07	115	140	12	140	175	172	235	90 −0,5	95	308	—	40	35	156	—	221	152	9,5	14 k 6	30	16,1	5	14 k 6	128,5	338	—	30	186		16,1	5
08	140			165						333	—			168	—		165							128	363	—		198			
09	135	185	16	165	225	215	283	112 −0,5	140,5	429	—	50	40	221	—	264	208	11,5	18 k 6	40	20,5	6	14 k 6	183,5	459	—	30	251		16,1	5
1	170			200						465	—			240	—		225							185	495	—		270			
2	160	230	20	200	280	270	346	140 −0,5	170	504	—	60	50	254	—	320	250	14	22 k 6	50	24,5	6	18 k 6	214	544	—	40	294		20,5	6
3	200			240						544	—			274	—		270								584	—		314			
4	180	270	25	230	330	315	409	160 −0,5	195	575	—	75	60	290	—	363	285	14	28 k 6	60	30,9	8	22 k 6	250	625	—	50	340		24,5	6
5	210			260						605	—			305	—		300								655	—		355			
6	220	330	28	280	400	385	477	200 −0,5	240	678	—	90	70	328	—	445	350	18	38 k 6	80	41,3	10	28 k 6	278	738	—	60	388		30,9	8
7	260			320						718	—			348	—		370								778	—		408			
8	250	370	32	330	450	442	557	225 −0,5	293	813	—	110	80	395	—	507	418	23	45 k 6	110	48,5	14	38 k 6	350	893	—	80	475		41,3	10
9	300			380						863	925			420	482		443								943	1005		500	562		
10	270	450	40	365	550	550	698	280 −1	315	900	965	120	100	450	515	625	450	27	55 m 6	110	58,8	16	45 k 6	425	1010	1075	110	560	625	48,5	14
11	310			405						940	1005			470	535		470								1050	1115		580	645		

D. C. GENERATORS, TYPES GNE – GHE – GCE

Type	Output kW 1500 rpm.	1000 rpm.	750 rpm.	600 rpm.	500 rpm.
521	300 b	190 b	140 a	105 a	80 a
523	350 c	220	160	120	90
525	400	250	180	135	100
621	450	290	200 b	160	120
623	540	340	240	190	150
625	630 d	400 c	290	220	180
721	730	450	335	260 b	210
723	850	540	390 c	300	245 b
725	1000	640	460	335	290

The D. C. Generators are delivered with shunt (type GNE), series (type GHE) or compound excitation (type GCE) with natural or separate ventilation; in the latter case the type indication is GNF.

Protective system: P 11 for the sizes 521 – 625, P 00 for the sizes 721 – 725.

Design: B 2, B 3, C 2 for the sizes 521 – 625; D 2, D 5, D 6, D 13 for the sizes 721 – 725.

Nominal voltages: a 115, 230, 460 volts; b 230, 460 volts; c 460 volts; d more than 550 volts on request.

All generators with other voltages or speed than indicated above on special request.

Regulation of voltage: For natural or separate excitation 1 : 0,1; self-excitation on special request.

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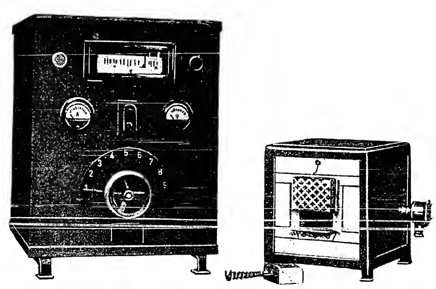


CHAMBER FURNACE TYPE KO 16

Small laboratory furnace for testing of material for annealing and incineration analyses, for burning and glazing small ceramic parts (for dentists). In the workshop the furnace serves for the heat treatment of smaller parts.

Design

The silite heating bars are arranged in the top part of the muffle above the working room. The muffle is shaped such as to leave behind a certain "heat cushion", when the door of the chamber is opened. The heat cushion makes it possible to reestablish the working temperature within a relatively short time. The muffle aperture is closed by means of a door stone with handle.

The furnace is fit for several hours' continuous operation at 1350° C. Its heat insulation, however, has been adapted to the conditions of intermitting operation, not for uninterrupted continuous operation. The furnace can also be connected to a 220-volt direct current power line. In this case there will be inserted a regulating resistor instead of a transformer. Taking account of small dimensions and occurring low electric loss of this regulating resistor, the compensable ageing reserve amounts in this case to about 33%, only.

When, operating with alternating current 220 volts, no stress is laid on an automatic regulation of the type KO 16, a simple transformer pulpit TRF 14 can be preset before the furnace.

In this case no switch pulpit EP 1 with instruments and thermo-elements is required.

Type	Approx. dimensions of usable space						Outside dimensions						Connected load kW appr.	Silite bars		Approx. weight	
	Width		Height		Depht		Width		Height		Depth			Number	Type		
	mm	inch.	mm	inch.	mm	inch.	mm	inch.	mm	inch.	mm	inch.				kg	lbs.
KO 16	60	2½	40	1½	180	8¼	300	12	305	12¼	420	17	2	3	8 × 180 (110)	22	48

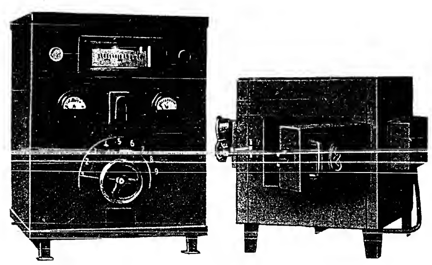
Switchboard

for the automatic temperature regulation, and for maintaining the constancy by means of temperature regulator 20° to 1600° C.

No. for orders	Approx. outer dimensions						Line voltage and sort of current		Approx-weight	
	Width		Height		Depth					
	mm	inch.	mm	inch	mm	inch.	volts	50 c.p.s.	kg*)	lbs.*)
EP 1	460	18½	600	24	540	21½	220	A.C.	55	121

*) Weight including transformer, step switch, magnetic switches, instruments, fuses, etc.

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



CHAMBER FURNACE TYPE KO 14

Universal furnace both for laboratories and workshops.

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Design

The silite heating bars are arranged horizontally in the upper part of the muffle, radiating in such a way freely into the working room.

The aperture in the muffle is closed by means of a folding-door. It can be perfectly tightened by means of a hand wheel.

The furnace is fit for economic operation during many hours at 1350° C. The load of the silite bars has been calculated such as to guarantee a long service life of a set of bars.

For thermal work under protective gas or hydrogen, this furnace can be equipped with a box of practically non-scaling special steel resistant to temperatures up to 1200° C.

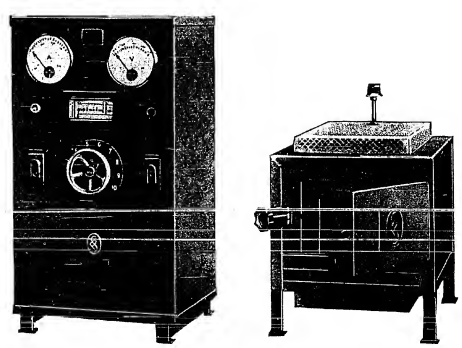
Type	Approx. dimensions of usable space						Outer dimensions						Connected load appr. kW	Silite bars		Approx. weight	
	Width mm	Width inch.	Height mm	Height inch.	Depth mm	Depth inch.	Width mm	Width inch.	Height mm	Height inch.	Depth mm	Depth inch.		Number	Type	kg	lbs.
KO14	150	6	100	4	250	10	490	19½	445	18	660	26½	4	7	8×150 (150)	62	136

Switchboard

for the automatic temperature regulation and for maintaining the constancy by means of temperature regulator 20° to 1600° C.

Type	Approx. outer dimensions						Line voltage and sort of current		Approx. weight	
	Width mm	Width inch.	Height mm	Height inch.	Depth mm	Depth inch.	volts	50 c.p.s.	kg *)	lbs.*)
EP 2	460	18½	600	24	540	21½	220	A.C.	106	233

*) Weight including transformer, step switch, magnetic switches, instruments, fuses, etc.



CHAMBER FURNACE ~~TYPE~~ KO 11

Workshop-furnace for the heat treatment of metals, for enamelling and burning ceramic parts. Also for more extensive laboratory work.

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Design

The base plates are ribbed on both sides. The ribs serve as guide bars for the material, and protect the heating bars from being kicked.
The silite heating bars are arranged vertically on both sides of the muffle.
The chamber aperture is closed by means of an equally well heat-insulated folding-door which can be perfectly tightened by means of a hand wheel.
The furnace is fit for economic 8 hours' operation at 1350° C.
For work with gases, this furnace, too, can be equipped with an easily movable box of special steel resistant to temperatures up to 1200° C.

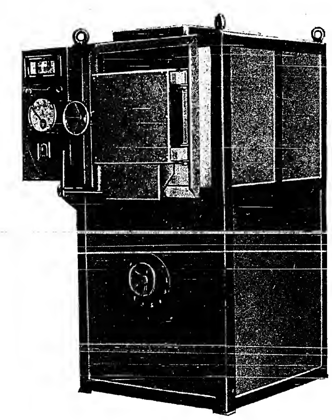
Type	Approx. dimensions of usable space						Outer dimensions						Connected load	Silite bars		Approx. weight	
	Width		Height		Depht		Width		Height		Depth						
	mm	inch.	mm	inch.	mm	inch.	mm	inch.	mm	inch.	mm	inch.	appr. kW	Num bar	Type	kg	lbs.
KO 11	200	8	180	7	500	20	555	22	650	26	875	35	8	12	8×180 (150)	130	286

Switchboard

for the automatic temperature regulation and for maintaining the constancy by means of temperature regulator 20° to 1600° C.

Type	Approx. outer dimensions						Line voltage and sort of current		Approx. weight	
	Width		Height		Depth					
	mm	inch.	mm	inch.	mm	inch.	volts	50 c.p.s.	kg*)	lbs.*)
DP 3	600	24	1100	44	460	21½	380/220	Three-phase current	160	352

*) Weight including transformer, step switch, magnexiv switches, instruments, fuses, etc.



CHAMBER FURNACE

TYPE KO 10,5

for workshops for versatile heat treatment

of metal and ceramic material.

Design

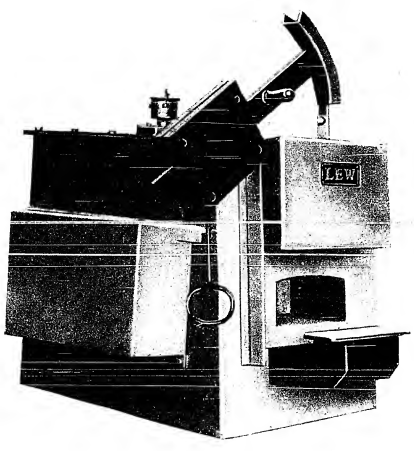
The silite heating bars are arranged freely radiating at the side walls of the muffle. The folding-door can be tightened by means of a hand wheel. The rake plate can be turned up and down by means of a lever.

The furnace is very well heat-insulated; it requires an extremely short heating time, and it is constructed for continuous operation at 1350° C.

The switch chest with perfectly automatic temperature regulation, with amperemeter, signal lamps and press button switch is fitted laterally. The transformer with step and magnetic switches and fuses is incorporated to the stand of the furnace.

Type	Approx. dimensions of usable space						Outer dimensions						Connected load appr.	Silite bars		Approx. weight	
	Width		Height		Depth		Width		Height		Depth			Number	Type	kg	cwts
	mm	Inch.	mm	Inch.	mm	Inch.	mm	inch	mm	Inch.	mm	Inch.	kW				
KO 10,5	220	9	220	9	520	21	1125	45	1610	64 1/2	980	39	14	12	14x200 (250)	700	15

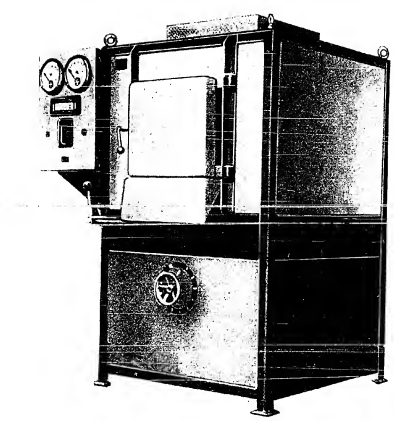
DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



VEM SILITE BAR CHAMBER FURNACE KELS

for hardening of tools

Connected load:	Size I 12 kW	size II 20 kW
Line voltage:	380 volts or 220 volts	
Maximum temperature:	1350° C	
Heating elements:	6 silite bars arranged at the ceiling	
Hearth:	Fire brincks	
Accessories:	Switching appliances with automatic temperature regulation and step transformer	
Internal dimensions:	Size I Width 200 mm (about 8 inches)	Size II Width 400 mm (about 16 inch.)
	Height 100 mm (about 4 inches)	Height 200 mm (about 8 inch.)
	Depth 350 mm (about 14 inches)	Depth 500 mm (about 20 inch.)
Weight of the furnace:	about 310 kg (about 6 cwts.)	about 1000 kg (about 1 ton.)



CHAMBER FURNACE TYPE KO 10

Workshop-furnace for annealing, hardening, thermal refining of metal parts, for glazing and burning of ceramic goods.

Design

The silite heating bars are arranged freely radiating on the side walls of the muffle. The door of the furnace is equipped with lever closure. The rake plate can easily be adjusted to the proper height for charging by operating a lever, after the door has been opened.

High efficiency of the furnace thanks to the freely radiating heat and the excellent heat insulation.

The furnace has been designed for continuous operation at 1350° C.

Type	Approx. dimensions of usable space						Outer dimensions						Connected load appr. kW	Silite bars		Approx. weight	
	Width		Height		Depht		Width		Height		Depht						
	mm	inch.	mm	inch.	mm	inch.	mm	inch.	mm	inch.	mm	inch.		Number	Type	kg	tons
KO 10	280	11	300	12	600	24	1050	42	1790	71½	1190	47½	25	12	18 × 300 (350)	1500	1½

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK DIA

The figure shows a special type of KO 9 with appliance for recording in colours

CHAMBER FURNACE TYPE KO 9

Industrial furnace for annealing, hardening, heat treating and thermal refining of metal parts, for glazing and burning of ceramic goods etc.

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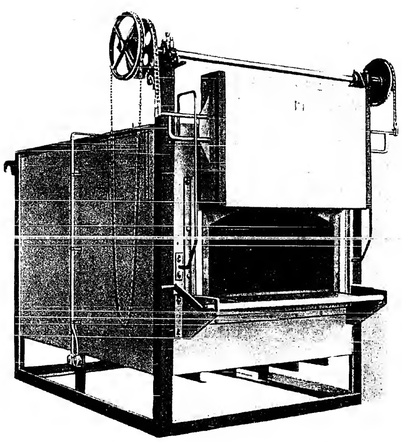
Design

The heating chamber is built of high-grade refractory fire bricks and surrounded by sufficient isolation layers.
The resistor elements, freely radiating silite bars, are arranged shock-protected on the side walls. They are fed and regulated by a transformer with step switch located in the stand of the furnace.
A rake plate can easily be adjusted to its working position by operating a lever, after the door has been opened.
The switch desk with the appliances for switching and temperature regulating forms a complete unit together with the furnace.
The furnace has been designed for continuous operation at 1350° C. But by adjusting the step switch it also admits working at lower temperatures and at a lower capacity.
Mains supply 220/380 volts three-phase current.

Type	Approx. dimensions of usable space						Outer dimensions						Connected load appr.	Silite bars		Approx. weight	
	Width		Height		Depth		Width		Height		Depth						
	mm	inch.	mm	inch.	mm	inch.	mm	inch.	mm	inch.	mm	inch.	kW	Number	Type	kg	tons
KO 9	540	21 1/2	375	15	810	32 1/2	1660	66 1/2	1930	77	1600	64	37	18	14 × 400 (350)	2800	2 1/2



VEM CHAMBER FURNACE TYPE KEEW

for annealing, hardening and cementing

	Size I	Size II
Connected load:	65 kW	100 kW

Nominal voltage: Three-phase current 380 volts or 220 volts

Maximum temperature: 950° C

Heating: Metallic heoting resistors in the bottom or at the ceiling.

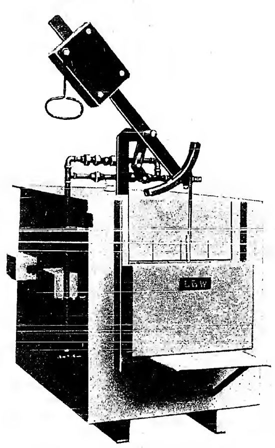
Hearth covering: Ni-chrome steel costing or carborundum.

Accessories: Switchboord with outomotic temperature regulotion.

These furnaces are also delivered with motor-operoted door lifting contrivonce and automatic star-delta connection.

Internal dimensions:		Size I	inches approx.	Size II	inches approx.
	Width	1000 mm	40	1200 mm	48
	Height	500 mm	20	500 mm	20
	Depth	2000 mm	80	2000 mm	80

Weight:	about 6500 kg	7100 kg
	obout 6½ tons	7 tons



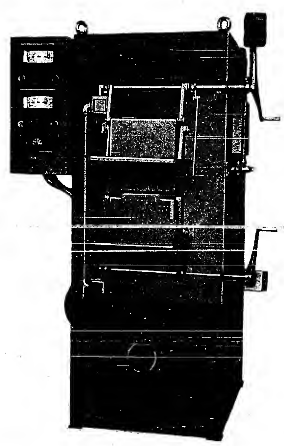
VEM CHAMBER FURNACE
WITH GAS VEIL CONTRIVANCE
TYPE KEEWIS

for hordening of tools
and annealing of work pieces.

Connected load:	10 kW
Nominal voltage:	Alternating current 220 volts or 380 volts
Maximum temperature:	950° C
Heating:	Metallic heating resistors in the bottom and at the ceiling
Hearth covering:	Ni-chrome steel casting plate
Accessories:	Switchboard with automatic temperature regulation.

The fitted gas veil contrivance cuts off the access of air, thus preventing an excessive scaling.

Internal dimensions:	350×200×500 mm. 14×8×20 inch. approx



DOUBLE CHAMBER FURNACE TYPE DKO 1

For regular annealing and hardening of tool steel and high-speed steel, gear wheels etc.

Design

The high-temperature chamber up to 1350° C is heated by means of silite bars, the preheating chamber up to 900° C by wire coils of best quality. The chambers of the furnaces are closed by means of easily movable parallelogram doors which, when being operated, also automatically adjust the rake plates to the proper position.

To prevent the access of air to the hardening chamber a contrivance for producing a veil of coal gas, can be incorporated if required. This veil becomes efficient automatically, when the door is operated.

The furnace stands an eight hours' operation at maximum temperatures.

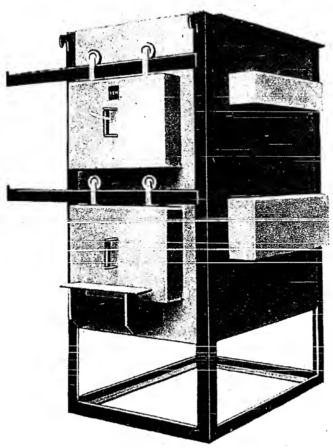
The switch chest with 2 temperature regulators, ammeter, signal lamps, equalizer coils etc. is fitted laterally to the furnace.

1 thermo couple Pt-Pt/Rh; 1 thermo couple NiNi/Cr.

Transformer with step switch and magnetic switches as well as fuses are incorporated to the stand.

The furnace has been designed for connection to 220/380 volts three-phase current.

Weight: about 1000 kg (about 1 ton)



VEM DOUBLE CHAMBER FURNACE TYPE KDLM

for hardening of tools

	Size I	Size II
Connected load		
of the preheating chamber	10 kW	15 kW
of the hardening chamber	20 kW	30 kW
Nominal voltage		
of the preheating chamber	220 volts or 380 volts AC	
of the hardening chamber	220 volts or 380 volts three-phase current	
Maximum temperature		
of the preheating chamber	900° C	
of the hardening chamber	1350° C	
Heating		
of the preheating chamber	metallic heating resistors in the bottom and at the ceiling	
of the hardening chamber	silite bars at the ceiling	
Hearth covering		
of the preheating chamber	Ni-chrome steel casting plate	
of the hardening chamber	Fire bricks	

Accessories: Switchboard with an automatic temperature regulator for each chamber. Step transformer for the hardening chamber

Internal dimensions

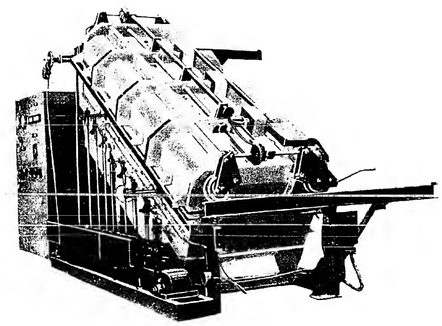
of the preheating chamber

	mm	inch.	mm	inch.
Width	370	15	370	15
Height	160/200	6½/8	250/280	10/11
Depth	500	20	800	32

of the hardening chamber

	mm	inch.	mm	inch.
Width	370	15	370	15
Height	160/200	6½/8	250/280	10/11
Depth	500	20	800	32

	Size I	Size II
Weight:	about 1900 kg	2800 kg
	about 2 kg	2¾ tons



VEM TILTING BUCKET FURNACE TYPE FYLW

Special furnace for heat treatment of powder material at temperatures up to about 700° C.

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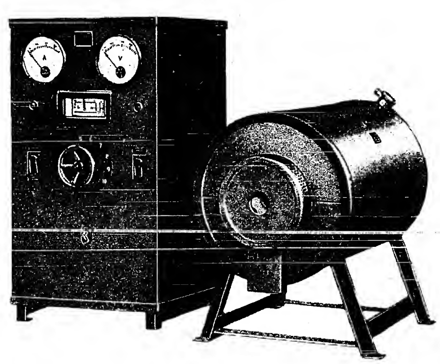
The material passes through the furnace from above downward. It is mixed up on passing from one tilting bucket to the following one.
The tilting bucket drive is controlled by a switch clock. Automatic temperature control. Discharging of the material mechanically and automatically.
This sort of furnace can only be used for powder material and under certain operating conditions.



TUBULAR FURNACES
TYPES RO 02, 04 TO 06
with switchboard DP 3

For annealing, hardening, cementing and other heat treatment of wires and strips, arrest point determination, calibration of thermo couples, gas heating, analyses etc.

Design

Outside diameter about 560 mm
Outside length about 810 mm
Length between ends of tube about 1200 mm
Height of furnace about 800 mm
Width of foot about 700 mm

Diameter of working tube alternatively from 20/30 to 50/65 mm. Heated tube length 600 mm. Switchboard.

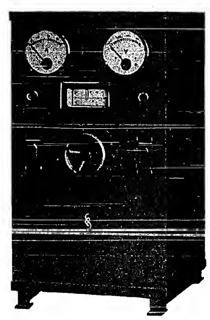
Type	Dimensions of working tube			Connected load	Silite bars		Approx. weight	
	Inside-, Outside-diameters	Heated tube length	Total length		Numbers	Type *)		
	mm	mm	mm	in kVA		mm	kg	cwts.
RO–02	20/30	600	1200	9–13,5	6	18×600 (150)	190	3 1/2
RO–04	30/40	600	1200	9–13,5	6	18×600 (150)	190	3 1/2
RO–05	40/50	600	1200	9–13,5	6	18×600 (150)	190	3 1/2
RO–06	50/65	600	1200	9–13,5	6	18×600 (150)	190	3 1/2

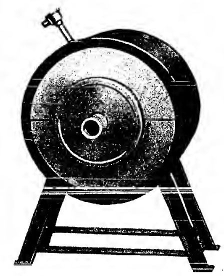
*) Diameter and length of glowing part, in brackets length of the thickened end.

Regulating and measuring implements for this furnace ready for being connected can be supplied combined in a switchboard. For the above stated tubular furnaces the following implements are available:

Type	Outside dimensions approx.	Line voltage and sort of current		Suitable for furnaces types	Approx. Weight	
		volts	50 c.p.s.		kg	cwts.
DP 3	600×1110×460 mm 24×44 1/2×18 1/7 inch.	380×220	Three-phase current	RO–02 to 06	160	3

*) Weight including transformer, step switch, magnetic switches, instruments, fuses, etc.





TUBULAR FURNACES TYPES RO 03, 07 to 09

with switchboard DP 3

For annealing, hardening, cementing and other heat treatment of wires and strips, arrest point determination, calibration of thermo couples, gas heating, analyses etc.

Design

Outside diameter	about 560 mm
Outside length	about 510 mm
Length between ends of tube	about 900 mm
Height of furnace	about 800 mm
Width of foot	about 700 mm

Width of working tube alternatively from 20/30 to 50/65 mm. Heated tube length 300 mm.

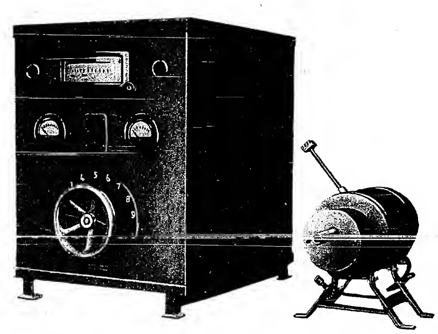
Type	Dimensions of working tube			Connected load	Silite heating bars		Approx. weight	
	Inside-, Outside-diameters mm	Heated length of tube mm	Total length mm	in kVA	Number	Types *) mm	kg	lbs.
RO 03	20/30	300	900	9	6	14 × 300 (150)	110	242
RO 07	30/40	300	900	9	6	14 × 300 (150)	110	242
RO 08	40/50	300	900	9	6	14 × 300 (150)	110	242
RO 09	50/65	300	900	9	6	14 × 300 (150)	110	242

*) Diameter and length of glowing part, in brackets length of the thickened end.

Regulating and measuring implements for this furnace ready for being connected can be delivered combined in a switchboard. For the above mentioned tubular furnaces the following implements are available:

Type	Outside dimensions approx.	Line voltage and sort of current		Suitable for furnaces types	Approx. weight	
		Volts	50 c.p.s.		kg	lbs.
DP 3	600 × 1100 × 460 mm 24 × 44 × 18 1/2 inch.	380/220	Three-phase current	RO 03 to 09	160	352

*) Weight including transformer, step switch, magnetic switches, instruments, fuses, etc.



SMALL LABORATORY FURNACE

TYPE CSBO 01 WITH SWITCHBOARD EP 1

Special furnace for laboratory analyses, particularly for the quick determination of the carbon and sulphur contents in steel.

Design

The furnace CSBO 01 has been designed for intermittent operation at 1350° C. The furnace is heated up to the maximum working temperature of 1350° C which, at the power rate of 2 kW will be reached within a short operating time. After the analysis the furnace should be switched off for cooling down. To maintain the nominal temperature, a power rate of 1,3kW will be sufficient as a rule.
1200° C are admissible for the 8 hours' shift.

Height of furnace about 330 mm = about 13 inches
Width of foot about 270 mm = about 11 inches

Mains supply

Alternating current or direct current 220 volts. In the first case there must be inserted to the circuit a switchboard type EP 1, in the latter case a regulating resistor.

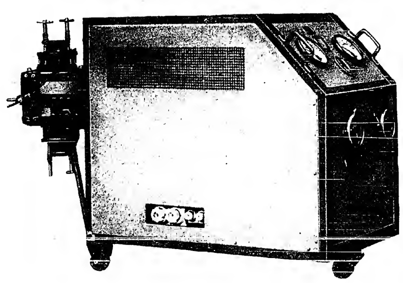
Type	Approx. dimensions of working tube						Connected load	Silite heating bars		Approx. weight	
	Inside-, Outside-diameter		Heated tube length		Total length			Numbers	Type*)		
	mm	inch.	mm	inch.	mm	inch.	in kVA		mm	kg	lbs.
CSBO-01	18/23	$^{3}/_{4}$-1	180	7	500	20	2	3	8×180 (60)	4,6	10

*) Diameter and length of glowing part, in brackets length of the covered end.

Regulation and measuring implements for this furnace ready for being connected can be delivered combined in a switchboard.
For the above mentioned tubular furnaces the following implements are available:

Type	Approx. outside dimensions mm						Line voltage and sort of current		Approx. weight	
	Width		Height		Depht		Volts	50 c.p.s.		
	mm	inch.	mm	inch.	mm	inch.			kg	lbs.
EP 1	460	$18^{1}/_{2}$	600	24	540	$21^{1}/_{2}$	220	Alternating current	55	121

*) Weight including transformer, step switch, magnetic switches, instruments, fuses, etc.



Carbon tube furnace KRO 19 with movable switchboard

ELECTRIC CARBON TUBULAR FURNACES

for temperatures up to 2500° C

For industrial purposes and laboratories for melting of difficultly melting metals and chemical combinations. For the manufacture of hard metals, for testing of high-grade refractory materials, for optical and dilatometrical determinations and many other purposes requiring very high temperatures.

Design

A carbon tube is inserted between two graphite packages to the low-voltage circuit of a regulable transformer. Depending on the adjustment of the step transformer, the current heat heats the carbon tube up to 2500° C Crucibles which are adapted to the melting material (metals – alloys – silicates etc.) are inserted to the carbon tube which is equipped with a bottom. The material of the crucibles is such as to avoid any chemical influencing of the melt.

The carbon tube can be easily and quickly interchanged. Low jacket temperature and low heat loss thanks to the excellent heat insulation. The furnace can be hung in to the current supply rails. It may be turned and fixed in any position. The efficiency of the furnace can be regulated by means of a coarse and fine step switch.

Transformer, step switch, voltmeter and ammeter, main switch, signal lamps and safety devices are located in a switch chest which can be moved together with the furnace.

Mains supply

Single-phase alternating current 50 c. p. s., all usual voltages.

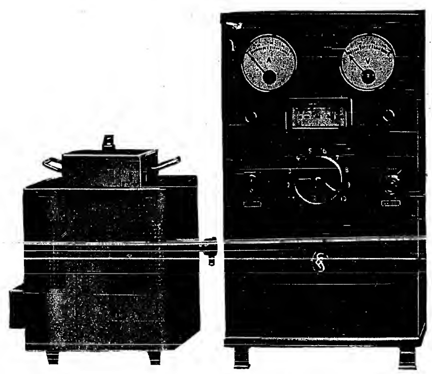
Carbon tube furnaces types KRO 18 to 22 for temperatures up to 2500° C.

Type	Dimensions of working tube						Connected load	Maximum crucible contents		Appr. weight with switch chest	
	Inside-diameter		Heated tube length		Total length						
	mm	inch.	mm	inch.	mm	inch.	kVA	cm^3	cubic inch.	kg	cwts.
KRO 18	100	4	270	11	740	$29^1/_2$	50	1000	61	2000	40
KRO 19	38	$1^1/_2$	200	8	470	19	15	65	4	700	14
KRO 20	30	$1^1/_4$	200	8	450	18	12	55	$3^1/_3$	700	14
KRO 21	30	$1^1/_4$	180	7	450	18	10	45	$2^3/_4$	700	14
KRO 22	22	1	180	7	450	18	8	28	$1^3/_4$	550	11

Accessories and spare parts for carbon tube furnaces

We deliver the following accessories and spare parts for the carbon tube furnaces:

Carbon or graphite slip-in crucibles
Carbon heating tubes with or without bottom
Protective carbon tubes, carbon breeze, graphite powder
Electrographite insetrings
Fire brick jackets, fire brick rings
Temperature measuring instruments for temperatures up to 2500° C.



CRUCIBLE MELTING FURNACE TYPE TIO 3

with switchboard DP 3

Workshop-furnace for melting and refining metals.

An easily removable crucible holding 3 cubic-decimeters serves for taking up the melting material.

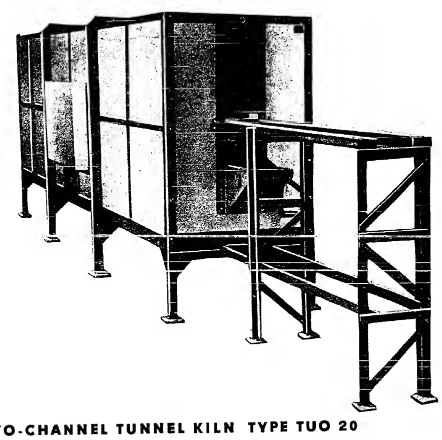
The heating chamber of the furnace is made of first-class Superdia material and surrounded by best heat insulating materials. The crucible is heated by means of freely radiating silite heating bars arranged at the side walls of the muffle.

The opening of the crucible is locked by means of a lid which catches into a sand cup for guaranteeing a good packing. This lid can be easily removed by hand.

The furnace has been designed for the economic operation during many hours at 1200° C in the crucible.

Line voltage 220/380 volts three-phase current.

Weight of the furnace about 94 kg = about 207 lbs.



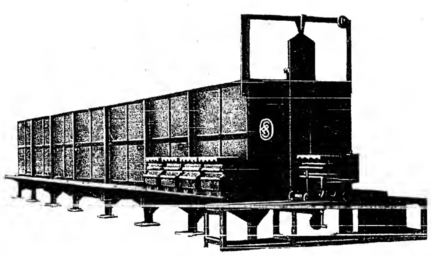
TWO-CHANNEL TUNNEL KILN TYPE TUO 20

(for silite heating)

The kiln has a preheating, burning and cooling zone.
It is used for burning small ceramic parts.
Temperature of burning zone 1350° C.
Cross section of channel 150×170 mm each (about 6×7 inches each).
Length of channels 6 meters (about 6½ yds.).
Connected load 32 kW.
The plates are moved through by means of a crank.
Automatic temperature regulation in the preheating and burning zones by means of 4 thermo couples and regulating instruments.
Ageing compensation of heating bars by means of transformers with step switches in a separate switch chest.

Dimensions: Total length including discharge stands 10,5 m (about 11½ yds.),
total width 1,1 m (about 1 1/4 yds.),
total height 1,96 m (about 2 1/7 yds.).

Weight: about 12 tons.

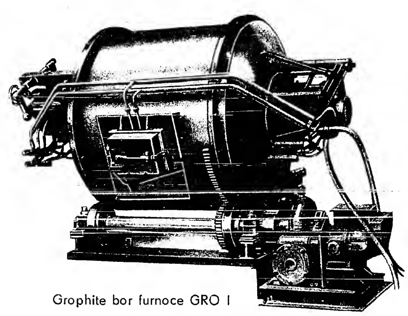


CAR TUNNEL KILN TYPE TUO 23

The electric tunnel kiln is equipped with silite heat resistors ond automotic temperoture regulotion. It has o preheating, burning ond cooling zone ond serves for burning ceromic objects in continuous operation.
Connected lood 80 kW at 220/380 volts. The moteriol to be burnt is rhythmicolly moved through the chonnel zone of the kiln on the cars running on rails which are introduced by motor power.

The main dimensions of the tunnel kiln are:

Total length including trovelling plotform	about 14,5 m =	about 16 yards
Length of chonnel	about 13,5 m =	about 15 yords
Width of chonnel	about 0,32 m =	about 13 inch.
Usable height of chonnel	obout 0,5 m =	about 20 inch.
Outside height of kiln	about 2,6 m =	obout 2¾ yds.
Number of cars	24	
Weight:	25 tons	



Grophite bor furnoce GRO I

GRAPHITE BAR FURNACE TYPE GRO 1

The furnoce serves for quick melting of metols ond alloys os well os for melting silicates, such os welding electrode flux, when the furnace is saturoted with corbon.

Design

In the middle axle of the drum-shaped furnace there is arranged a graphite bar fitted into strong carbon electrodes by which it is supplied with electric current from a one-phase step transformer.

The current is delivered to these electrodes over watercooled couples of clamping jaws. The bar itself takes up temperatures up to 2000° C.

Usable space about 150 litres; the furnace can be designed for an output up to 500 kVA, depending on the theoretical production required. The drum with an outside diameter of about 2000 mm (about 80 inch.) can be turned upward by 160° by swinging motions during the melting process, and downward by 30° for emptying. These motions are automatically controlled.

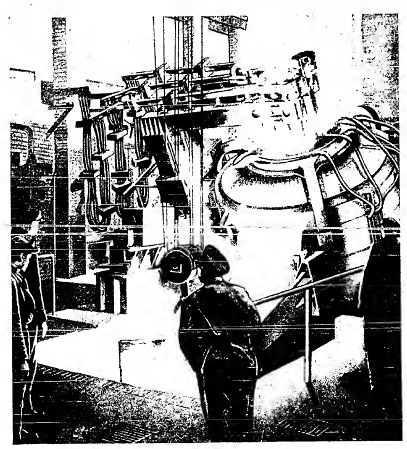
In the middle of the jacket there are a spout for emptying and a door with water-cooled frame for filling.

A motor-driven double worm gear with regulating starter, control appliances and safety devices transfers the swinging motions to the body of the furnace running on rollers.

Accessories

Switchdesk with incorporated control instruments, voltmeter and ammeters, signal lamps and fuses, spare graphite bars; carbon electrodes for the current supply and graphite inset pieces.

Further information willingly upon demand.



VEM ELECTRIC STEEL ARC FURNACE

to be firmly inserted

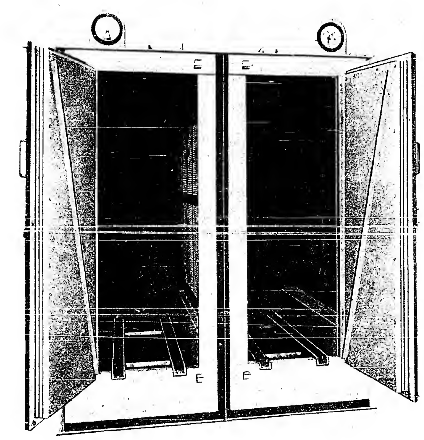
Power output: 2000 kVA respectively 2500 kVA

Electrodes: Graphite 250 mm diameter = about 10 inches.

The electric steel arc furnaces according to Héroult are built in the following sizes:

Furnaces holding 3 tons	1200 kVA
Furnaces holding 5 tons	2000 kVA resp. 2500 kVA
Furnaces holding 10 tons	4300 kVA
Furnaces holding 18 tons	6000 kVA

The furnaces holding 5 tons and more are charged by baskets. All plants have a special step transformer and choking coil. They are all equipped with automatic electrode control mechanism.



VEM DOUBLE-CHAMBER DRYING CABINET TYPE KWDR

for drying of work pieces

The drying cabinets are also delivered with tubular radiators, so that they can be used for drying of varnish.

Connected load for each chamber: 30 kW

Nominal voltage: 380 volts

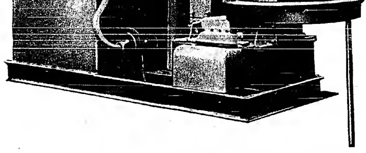
Maximum temperature: 250° C

Heating: Heating frames

Accessories: Switchboard with automatic temperature regulation and carriages for conveying the material to be dried.

Internal dimensions
each chamber: width 600 mm = 24 inches
height 1700 mm = 68 inches
depth 1200 mm = 48 inches

Weight: about 2700 kg = about 54 cwts.



VEM TIRE PREHEATING PLANT

This is a special plant for preheating tires for wheels of locomotives and railway carriages.
The plant is working according to the transformer principle, the tire representing the secondary winding.

Power output of the transformer: 100 kVA
Heating time: 20 to 40 minutes, depending on size and weight of the tire.
Nominal voltage: Alternating current 220 volts or 380 volts.
Weight: about 3750 kg = about 73 cwts.

TABLE OF CONTENTS

FITTINGS FOR CABLES AND OVERHEAD LINES

Group 12

Joint ers and connectors . . . . a

Notch jointers . . . . a 1

Rivet jointers, screw connectors . . . . a 2

Terminals and clamps . . . . b

Overhead line terminals, cable jointers . . . . b 1

Cable sockets . . . . b 2

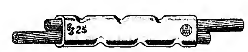
Other terminals . . . . b 3

Fittings for high tension lines c

Terminal and protective fittings . . . . c 1

Intermediate terminal boxes . . . . d 1

House distribution boxes, pole trifurcating boxes . . . . d 2



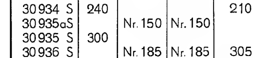
NOTCH JOINTERS,

made of fire-zinced steel,

for steel ropes

No. for orders	Rope section	Rope diameter approx.		Length of the notch jointer approx.		Weight 100 pieces approx.	
	mm^2	mm	inch.	mm	inch.	kg	lbs.
35924	10	4,1	$^5/_{32}$	63	$2^1/_2$	1,4	$3^1/_{16}$
35925	16	5,1	$^{13}/_{64}$	98	$3^7/_8$	4,6	$10^1/_8$
35926	25	6,3	$^1/_4$	112	$4^7/_{16}$	6,3	$13^3/_4$
35927	35	7,5	$^{19}/_{64}$	126	5	8	$17^3/_4$
35928	50	9	$^{23}/_{64}$	180	$7^1/_8$	12,9	$28^1/_2$
35929	70	10,5	$^7/_{16}$	198	$7^{13}/_{16}$	16,2	$35^3/_4$
35930	95	12,5	$^1/_2$	264	$10^3/_8$	25	55

NOTCH JOINTERS of pure aluminium

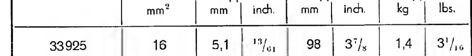


for current loop connections formed by steel aluminium ropes

No. for orders	1:6 mm²	Jointers fit for steel aluminium ropes 1:6	1:4	1:3 with 80 kg/mm² strength of steel mm²	Ø	vibration damping mm²	Weight 100 pieces approx. kg	lbs.
30925 S	16						2,6	$5\frac{3}{4}$
30926 S	25						3,4	$7\frac{1}{2}$
30927 S	35		Nr. 16				4,3	$9\frac{1}{2}$
30928 S	50		Nr. 25				7,3	16
30929 S	70	Nr. 35	Nr. 35				10,9	24
30930 S	95	Nr. 50	Nr. 50			95	20,3	$44\frac{3}{4}$
30931 S	120	Nr. 70	Nr. 70			120	29,8	$65\frac{3}{4}$
30932 S	150					150	40,2	$88\frac{1}{2}$
30932aS		Nr. 95	Nr. 95			165	46,2	102
30933 S	185					185	47	$103\frac{1}{2}$
30934aS	210	Nr. 120	Nr. 120			210	55,6	$122\frac{1}{2}$
30934 S	240			210	22,2	240	76	$167\frac{1}{2}$
30935aS		Nr. 150	Nr. 150				151	333
30935 S	300						145	320
30936 S		Nr. 185	Nr. 185	305	26,6		143	315
30937 S				340	28		154	340

Measurements and tool specifications for these jointers

No. for orders	Length of the jointer mm	appr inch.	Internal measures mm	appr. inch.	Number of notches	Hight of the notches mm	appr. inch.	Notching gauges, fitting these jointers: Sz. II No. for orders	Sz. III No. for orders	Notching pliers No. for orders
30925 S	100	4	6 x14	$\frac{15}{64}\times\frac{9}{16}$	6	13	$\frac{33}{64}$	05240		05526a
30926 S	114	$4\frac{1}{2}$	7,5x16,5	$\frac{19}{64}\times\frac{21}{32}$	6	15	$\frac{19}{32}$	05241		05526a
30927 S	130	$5\frac{1}{8}$	9 x19	$\frac{23}{64}\times\frac{3}{4}$	6	17,5	$\frac{11}{16}$	05242		05526a
30928 S	184	$7\frac{1}{4}$	10,5x22	$\frac{7}{16}\times\frac{7}{8}$	8	20	$\frac{25}{32}$	05243		05526a
30929 S	204	$8\frac{1}{4}$	12,5x26	$\frac{1}{2}\times1\frac{1}{16}$	8	25	1	05244		05526a
30930 S	294	$11\frac{5}{8}$	15 x31	$\frac{19}{32}\times1\frac{3}{16}$	10	29	$1\frac{1}{8}$	05245		05526a
30931 S	400	16	17 x35,5	$\frac{21}{32}\times1\frac{7}{16}$	12	33	$1\frac{5}{16}$		05330	05529
30932 S	413	$16\frac{1}{2}$	19 x39	$\frac{3}{4}\times1\frac{1}{2}$	12	36	$1\frac{7}{16}$		05331	05529
30932aS	428	17	20 x41,5	$\frac{25}{32}\times1\frac{5}{8}$	12	38	$1\frac{1}{2}$		05341	05529
30933 S	432	$17\frac{1}{4}$	21 x43	$\frac{13}{16}\times1\frac{11}{16}$	12	39	$1\frac{9}{16}$		05332	05529
30934aS	496	$19\frac{1}{2}$	22 x45,5	$\frac{7}{8}\times1\frac{3}{4}$	14	41	$1\frac{5}{8}$		05333	05529
30934 S	522	$20\frac{1}{4}$	24 x48,5	$\frac{15}{16}\times1\frac{7}{8}$	14	41	$1\frac{5}{8}$		05334	05529
30935aS	685	27	26 x53	$1\frac{1}{16}\times2\frac{1}{16}$	18	50	2		05335	05529
30935 S	685	27	26 x53	$1\frac{1}{16}\times2\frac{1}{16}$	18	50	2		05335	05529
30936 S	620	$24\frac{1}{2}$	29 x58	$1\frac{1}{8}\times2\frac{5}{16}$	16	55	$2\frac{3}{16}$		05336	05529
30937 S	620	$24\frac{1}{2}$	30,5x61	$1\frac{3}{16}\times2\frac{7}{16}$	16	58	$2\frac{5}{16}$		05337	05529



NOTCH JOINTERS

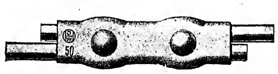
made of pure aluminium

for pure aluminium ropes

No. for orders	Rope section mm²	Rope diameter approx. mm	inch.	Length of the notch jointer approx. mm	inch.	Weight 100 pieces approx. kg	lbs.
33925	16	5,1	$\frac{13}{64}$	98	$3\frac{7}{8}$	1,4	$3\frac{1}{16}$
33926	25	6,3	$\frac{1}{4}$	112	$4\frac{7}{16}$	1,9	$4\frac{3}{16}$
33927	35	7,5	$\frac{19}{64}$	126	5	2,4	$5\frac{5}{16}$
33928	50	9	$\frac{23}{64}$	180	$7\frac{1}{8}$	4,1	9
33929	70	10,5	$\frac{7}{16}$	198	$7\frac{13}{16}$	5	11
33930	95	12,5	$\frac{1}{2}$	264	$10\frac{3}{8}$	11,1	$24\frac{1}{2}$
33931	120	14	$\frac{9}{16}$	286	$11\frac{9}{32}$	12,5	$27\frac{1}{2}$
33932	150	15,8	$\frac{5}{8}$	308	$12\frac{5}{32}$	15,2	$33\frac{1}{2}$
33933	185	17,5	$\frac{11}{16}$	330	13	18,6	41
33934	240	19,6	$\frac{25}{32}$	416	$16\frac{25}{64}$	34,2	$75\frac{1}{2}$

RIVET JOINTERS IN ONE PIECE

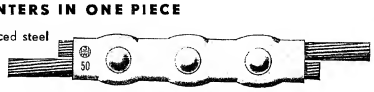
made of fire-zinced steel
with 2 rivets
for steel wires



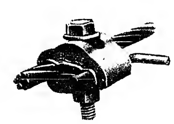
No. for orders	Wire section mm²	Wire diameter mm	Wire diameter appr. inch.	Number of jointers, necessary to obtain standard strength: for tension-proof joints in the field and for connecting the extension rope to the main rope	Number of jointers: for terminating ropes	Weight 100 pieces approx. kg	Weight 100 pieces approx. lbs.
15204	10	3,5	$^{9}/_{64}$	1	1	1,75	$3^{3}/_{4}$
15206	16	4,5	$^{11}/_{64}$	1	1	3,2	7

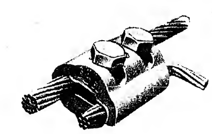
RIVET JOINTERS IN ONE PIECE

mode of fire-zinced steel
with 3 rivets
for steel ropes



No. for orders	Rope section mm²	Rope diameter mm	Rope diameter appr inch	Number of jointers, necessary to obtain standard strength: for tension-proof joints in the field and for connecting the extension rope to the main rope	Number of jointers: for terminating ropes	Weigth 100 pieces approx. kg	Weigth 100 pieces approx. lbs
15325	16	5,1	$^{13}/_{64}$	2	1	3,5	$7^{3}/_{4}$
15326	25	6,3	$^{1}/_{4}$	2	1	6	$13^{1}/_{4}$
15327	35	7,5	$^{19}/_{64}$	2	1	8,7	$19^{1}/_{4}$
15328	50	9	$^{23}/_{64}$	2	1	13,5	$29^{3}/_{4}$
15329	70	10,5	$^{7}/_{16}$	2	1	17,3	$38^{1}/_{4}$
15330	95	12,5	$^{1}/_{2}$	2	1	22,8	$50^{1}/_{4}$



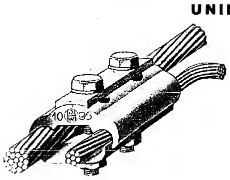


UNIMAX SHUNTING TERMINALS

made of steel
fire-zinced with copper linings
for copper power lines

No. of orders	Number of bolts	Clamping range for copper conductors mm²	Bolt diameter approx. mm	Bolt diameter approx. inch.	Weight 100 pieces approx. kg	Weight 100 pieces approx. lbs.
27326	1	6 – 25	6	$^{15}/_{64}$	6,15	$13^{1}/_{2}$
27326 a	2	6 – 25	6	$^{15}/_{64}$	12,2	27
27328 a	2	6 – 50	8	$^{5}/_{16}$	23	$50^{3}/_{4}$
27330	2	16 – 95	10	$^{25}/_{64}$	41,5	$91^{1}/_{2}$

UNIMAX SHUNTING TERMINALS



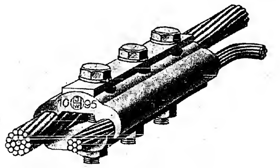
made of pure aluminium

with galvanized bolts, nuts and washers of steel

with 2 bolts

for connection of 2 lines of different diameter

No. for orders	Clamping range aluminium conductor	Steel aluminium ropes with total diameter approx.		Bolt diameter approx.		Weight 100 pieces approx.	
	mm^2	mm	inch	mm	inch.	kg	lbs.
23927 o	6 – 35	8	$^5/_{16}$	6	$^{15}/_{64}$	6,6	$14^1/_2$
23928 o	6 – 50	9,5	$^3/_8$	8	$^5/_{16}$	11	$24^1/_4$
23929 o	6 – 70	11	$^7/_{16}$	8	$^5/_{16}$	12,4	$27^1/_4$

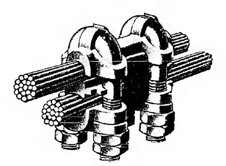


with 3 bolts

for 2 lines' connection of about same diameter

No. for orders	Clamping range aluminium conductor	Steel aluminium ropes with total diameter approx.		Bolt diameter approx.		Weight 100 pieces approx.	
	mm^2	mm	lbs.	mm	inch.	kg	lbs.
23930	10 – 95	12,5	$^1/_2$	8	$^5/_{16}$	22	$48^1/_2$
23932	10 – 150	16	$^5/_8$	10	$^{13}/_{32}$	37	$81^1/_2$

TOOTHED TERMINALS



for tension-proof, current-carrying line-connections

made of pressed, tempered, corrosion-proof aluminium

With 2 galvanized stud bolts and double nuts of steel, with linings, made of tempered aluminium

No. for orders	Clamping range aluminium and Aldrey conductors	total diameter		Number of toothed terminals, necessary to obtain standard strength: for tension-proof connections in the field and for connecting the extension rope to the main rope	for terminating ropes	Diameter of the stud bolts		Weight 100 pieces approx.	
	mm^2	mm	appr. inch.			mm	appr. inch.	kg	lbs.
23128 o	25-50	9,5	$^3/_8$	1	1	8	$^5/_{16}$	18,2	40
23130 o	70-95	12,5	$^1/_2$	1 resp. 2 *)	1	10	$^{25}/_{64}$	34,9	77
23132 o	120-150	16	$^5/_8$	1	1	12	$^{15}/_{32}$	65	$143^1/_4$
23134 a	185-240	21	$^{13}/_{16}$	2	1	14	$^9/_{16}$	100	$220^1/_2$
for steel aluminium ropes									
23128 o	25	6,8	$^{17}/_{64}$	2	1	8	$^5/_{16}$	18,2	40
23128 o	35	8,1	$^5/_{16}$	2	1	8	$^5/_{16}$	18,2	40
23130 o	50	9,6	$^3/_8$	2	1	10	$^{25}/_{64}$	34,9	77
23130 a	70	11,6	$^{29}/_{64}$	2	1	10	$^{25}/_{64}$	34,9	77
23132 o	95	13,4	$^{17}/_{32}$	2	1	12	$^{15}/_{32}$	65	$143^1/_4$
23132 a	120	15,7	$^5/_8$	3	2	12	$^{15}/_{32}$	65	$143^1/_4$
23134 o	150	17,3	$^{21}/_{32}$	3	2	14	$^9/_{16}$	100	$220^1/_2$
23134 o	185	18,2	$^{23}/_{32}$	3	2	14	$^9/_{16}$	100	$220^1/_2$
23134 o	240	20,5	$^{13}/_{16}$	3	2	14	$^9/_{16}$	100	$220^1/_2$
				Toothed terminals as before. Made of fire-zinced, malleable cast iron. Bolts and double nuts of steel, with linings of tempered aluminium					
24136 o	300	21,5-26	$^{27}/_{32}$-$1^1/_{16}$	3–5	2–3	16	$^5/_8$	242	$533^1/_2$
24138 o	—	26-33	$1^1/_{16}$-$1^5/_{16}$	4–6	3–4	16	$^5/_8$	320	$705^1/_2$

The larger number of terminals is necessary for the greater conductor gross section.

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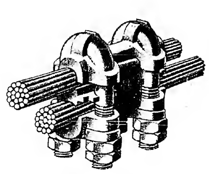
TOOTHED TERMINALS

for tension-proof line connections

made of fire-zinced malleable cast iron

with galvanized stud bolts, and double nuts of steel, with linings, made of tempered steel



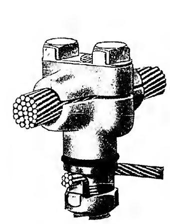
No. for orders	Clamping range: rope sections mm²	Clamping range: wire ropes mm²	Clamping range: wire ropes appr. inch.	Number of toothed terminals, necessary to obtain standard strength: for tension-proof connections in the field and for connecting the extension rope to the main rope	Number of toothed terminals: for terminating ropes	Diameter of the stud bolts appr mm	Diameter of the stud bolts appr inch	Weight 100 pieces approx. kg	Weight 100 pieces approx. lbs.
25126a	16-25	5-7	13/64-9/32	1	1	6	15/64	17,1	37 3/4
25128a	35-50	8-9	5/16-23/64	1 resp. 2*)	1	8	5/16	28,1	62
25130a	70-95	10-12	25/64-15/32	2 resp. 3*)	2	10	25/64	54	119
25132a	120-150	13-16	33/64-5/8	3	2	12	15/32	100	220 1/2
25134a	185-240	17-20	21/32-25/32	4	3	14	9/16	158	348
25136a	300-400	21,5-26	27/32-1 1/16	without linings				230	507
25138a		26-33	1 1/16-1 5/16	without linings				300	662

The larger number of terminals is necessary for the greater conductor cross section.

NOVALCU SHUNTING TERMINALS

with bolts of steel

galvanized

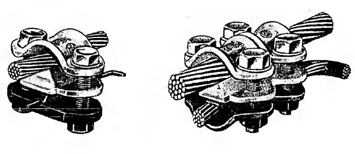


No. for orders	Clamping range: copper conductors mm²	Clamping range: aluminium conductors mm²	Steel aluminium rope total diameter approx mm	Steel aluminium rope total diameter approx inch.	Bolt diameter approx. mm	Bolt diameter approx. inch.	Weight 100 pieces approx. kg	Weight 100 pieces approx. lbs.
29 850	4–16	16– 35	7,5	19/64	8	5/16	12,8	28 1/4
29 851	4–16	50– 70	10,5	7/16	8	5/16	12,4	27 1/4
29 852	25–50	16– 35	7,5	19/64	8	5/16	16,7	37
29 853	25–50	50– 70	10,5	7/16	8	5/16	16,3	36
29 854	4–16	95–120	14	9/16	10	25/64	19,8	43 1/2
29 855	4–16	150–185	17,5	11/16	10	25/64	18,6	41
29 856	25–50	95–120	14	9/16	10	25/64	23,3	51 1/2
29 857	25–50	150–185	17,5	11/16	10	25/64	22,3	49
29 858	70–95	95–120	14	9/16	10	25/64	29,8	66
29 859	70–95	150–185	17,5	11/16	10	25/64	28,6	63

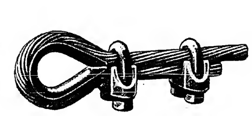
Novalcu shunting terminals may be used for pure aluminium lines as well as for Aldrey or steel aluminium lines.

AL-CU SADDLE CLAMPS

with bolts and nuts, made of galvanized steel



No. for orders	Clamping range: copper conductors mm²	Clamping range: aluminium conductors mm²	Steel aluminium rope total diameter approx. mm	inch.	Bolt diameter approx. mm	inch.	Weight 100 pieces approx. kg	lbs.
Single clamps								
29 830	6– 35	6– 35	7,5	19/64	6	15/64	8,8	19 1/2
29 831	25– 95	25– 95	12,5	1/2	8	5/16	17,8	39
Double clamps								
29 840	16– 70	16– 70	10,5	7/16	6	15/64	17,2	38
29 841	25–150	25–150	15,8	5/8	8	5/16	34,5	76

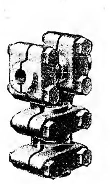


U-SHAPED WIRE ROPE CLAMPS

Body of top quality fire-zinced malleable cast iron,

Bow of galvanized steel

No. for orders	Rope wire diameter up to mm	inches	Weight 100 pieces approx. kg	lbs.
15754	6	1/4"	3,7	8 1/4
15756	8	5/16"	5,7	12 1/2
15759	11	7/16"	10,3	22 3/4
15760	14	9/16"	18,9	41 3/4
15761	16	5/8"	23,7	52 1/4
15762	19	3/4"	28,2	62 1/4



T-CONNECTORS

made of tempered, corrosion-proof aluminium,
with bolts of galvanized steel
for aluminium power-lines

with 4 binding lids

No. for orders	Type size	Conductor diameter		Rope section	Bolt diameter		Weight 100 pieces approx.	
		mm	approx. inches	mm²	mm	approx. inches	kg	lbs.
73217a	A 12	6	$^{15}/_{64}$	25	6	$^{15}/_{64}$	18,5	41
73217b	A 12	8	$^{5}/_{16}$	35	6	$^{15}/_{64}$	18	$39^{3}/_{4}$
73217c	A 12	10	$^{25}/_{64}$	50/70	6	$^{15}/_{64}$	17,8	$39^{1}/_{4}$
73217	A 12	12	$^{15}/_{32}$	95	6	$^{15}/_{64}$	17,3	$38^{1}/_{4}$
73219a	A 20	14	$^{9}/_{16}$	120	8	$^{5}/_{16}$	43,5	96
73219b	A 20	16	$^{5}/_{8}$	150	8	$^{5}/_{16}$	42	$92^{1}/_{2}$
73219c	A 20	18	$^{23}/_{32}$	185	8	$^{5}/_{16}$	40,5	89
73219	A 20	20	$^{25}/_{32}$	240	8	$^{5}/_{16}$	39	86
73221a	A 30	22	$^{7}/_{8}$	300	10	$^{25}/_{64}$	87	192
73221b	A 30	26	$1^{1}/_{16}$	400	10	$^{25}/_{64}$	80,2	177
73221c	A 30	28	$1^{1}/_{8}$	—	10	$^{25}/_{64}$	76,4	169
73221	A 30	30	$1^{3}/_{16}$	500	10	$^{25}/_{64}$	72,3	160

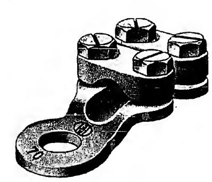
For connection of conductors of different diometer, compensoting sleeves ore supplied.

T-connectors moy serve to connect oluminium and copper, when used with electro-cupal sleeves.

CLAMP CABLE SOCKETS

made of pure aluminium

with bolts of galvanized steel
for pure aluminium ropes

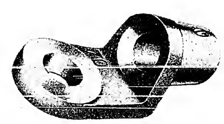


Easy mounting! Safe clamping! Good contact!

No. for orders	Conductor section	Diameter of the eye		Hole diameter for the clamping bolt		Weight 100 pieces approx.	
	mm²	mm	approx. inches	mm	approx. inches	kg	lbs.
53726a	16–25	19	$^{3}/_{4}$	9	$^{23}/_{64}$	2,1	$4^{1}/_{2}$
53727	35	21	$^{13}/_{16}$	9	$^{23}/_{64}$	2,3	5
53728	50	23	$^{29}/_{32}$	9	$^{23}/_{64}$	3,2	7
53729	70	25	1	11	$^{7}/_{16}$	5,7	$12^{1}/_{2}$
53730	95	27	$1^{3}/_{32}$	11	$^{7}/_{16}$	6,9	$15^{1}/_{4}$
53731	120	28	$1^{1}/_{8}$	11	$^{7}/_{16}$	8,5	$18^{3}/_{4}$
53732	150	30	$1^{3}/_{16}$	14	$^{9}/_{16}$	10	22

Clamp coble sockets Nos. 53726a – 53728 ore equipped with slitted cylinder heod bolts.

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



CABLE SOCKETS

of aluminium

for cables to be welded

CABLE SOCKETS

of aluminium

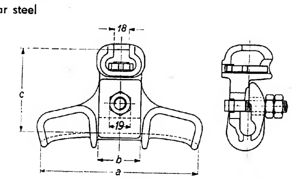
far cabies ta be weided

No. for orders	Conductor section mm²	Bolt diameter approx. mm	inch.	Inside diameter of the sleeve approx. mm	inch.	Diameter of the eye approx. mm	inch.	Weight 100 pieces approx. kg	lbs.
53824	10	6	15/64	4,5	11/64	19	3/4	1,05	2 1/4
53825	16	8	5/16	5,6	7/32	19	3/4	0,85	2
53826	25	10	25/64	7	9/32	22	7/8	2,25	5
53827	35	10	25/64	8,5	11/32	22	7/8	2,1	4 1/2
53828	50	10	25/64	10	25/64	28	7/8	4,9	11
53829	70	12	15/32	12	15/32	28	7/8	4,1	9
53830	95	16	5/8	13,5	17/32	35	1 3/8	7,35	16 1/4
53831	120	16	5/8	15	19/32	35	1 3/8	6,75	15
53832	150	16	5/8	16,5	21/32	40	1 9/16	11,8	26
53833	185	16	5/8	18	23/32	40	1 9/16	10,85	24
53834	240	22	7/8	21	13/16	45	1 3/4	15,35	34
53835	300	22	7/8	23,5	15/16	45	1 3/4	13,35	30

SUSPENSION TERMINALS

made of malleable cast iran ar steel

fire-zinced



Standard suspension terminal

Small-sized suspension terminals*)
(not for protective fittings)

No. for orders for copper	For insulators with tongue diameter mm	inch.	For rope diameter mm	approx inch.	Length of coiling band mm	approx. inch.	Weight 1 piece approx. kg	lbs
100600	11	7/16	4,1	5/32	550	22	0,77	1 3/4
100601	11	7/16	5,1– 5,4	13/64–7/32	550	22	0,77	1 3/4
100602	11	7/16	6,3– 6,8	1/4–17/64	550	22	0,77	1 3/4
100603	11	7/16	7,5– 8,1	19/64–5/16	550	22	0,77	1 3/4
100605	11	7/16	9 – 9,6	23/64–3/8	800	32	0,77	1 3/4
100667	11	7/16	10,5–11,6	7/16–29/64	800	32	0,77	1 3/4

Standard suspension terminals
(not for protective fittings)

No. for orders for copper	For insulators with tongue diameter mm	inch.	For rope diameter mm	approx. inch.	Length of coiling band mm	approx. inch.	Weight 1 piece approx. kg	lbs.
107603	16	5/8	5,1– 8,1	13/64–5/16	550	22	1,03	2 1/4
107607	16	5/8	8,2–11,6	21/64–29/64	800	32	1,2	2 1/2
107612	16	5/8	11,7–15	15/32–19/32	1200	48	1,35	3

Diagrams on request

*) Jllustration on request

SUSPENSION TERMINALS

of malleable cast iron or steel

fire-zincd

Fork-shaped suspension terminals*)

No. for orders for copper	No. for orders for olumin.	For insulator. with tongue diameter mm	approx. inch.	For rope diameter mm	approx. inch	Length of coiling band mm	oppr. inch.	Weight 1 piece approx. kg	lbs.
105603	105703	11	$^7/_{16}$	5,1– 8,1	$^{13}/_{64}$–$^5/_{16}$	550	22	0,745	$1^1/_2$
105607	105707	11	$^7/_{16}$	8,2–11,6	$^{21}/_{64}$–$^{29}/_{64}$	800	32	0,75	$1^1/_2$
106603	106703	16	$^5/_8$	5,1– 8,1	$^{13}/_{64}$–$^5/_{16}$	550	22	0,835	$1^3/_4$
106607	106707	16	$^5/_8$	8,2–11,6	$^{21}/_{64}$–$^{29}/_{64}$	800	32	0,84	$1^3/_4$
106618	106718	16	$^5/_8$	11,7–19,2	$^{15}/_{32}$–$^3/_4$	1600	64	1,5	$3^1/_4$

Fitting tonque sockets an request

Pendulaus suspension terminals with double fark*)

for semi-onchorages

No. for orders for copper	No. for orders for alumin.	Far insulotor. with tongue diameter mm	approx. inch.	For rope diameter mm	approx. inch.	Length af coiling band mm	oppr. inch.	Weight 1 piece approx. kg	lbs.
116603	116703	16	$^5/_8$	5,1– 8,1	$^{13}/_{64}$–$^5/_{16}$	550	22	1,93	$4^3/_{16}$
116607	116707	16	$^5/_8$	8,2–11,6	$^{21}/_{64}$–$^{29}/_{64}$	800	32	2,25	5
116612	116712	16	$^5/_8$	11,7–15	$^{15}/_{32}$–$^{19}/_{32}$	1200	48	3,14	7
116618	116718	15	$^{19}/_{32}$	15,1–19,2	$^{19}/_{32}$–$^3/_4$	1600	64	3,53	$7^3/_4$
116630	116730	16	$^5/_8$	19,3–24,2	$^3/_4$–$^{15}/_{16}$	2200	88	4,47	10
116650	116750	16	$^5/_8$	24,3–29	$^{31}/_{32}$–$1^1/_8$	2800	112	6,35	14

Extension strop No. 213505, as below, fits these terminols

Fitting tonque sockets on request

Extension strap for semi-anchorages

No. for orders	For insulators with tongue diameter mm	approx. inches	Fits semi-anchoroge clamps	Weight 1 piece approx. kg	lbs.
213505	16	$^5/_8$	No. 116603–650 No. 516703–750	2,2	$4^3/_4$

*) These fork-shoped suspension terminals ore not suitoble for the attachment of protective fittings Fastening couplers on request.

Diagrams on request

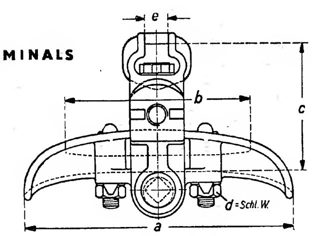
Jllustrotions on request

SUSPENSION TERMINALS

made of malleable

cast iron or steel

fire-zinced



Pendulous suspension terminal with short tongue socket

Pendulaus suspension terminals with short tongue socket

suitable for fastening of protective horns according to No.s for order 349514 or 359514

No. for orders for capper	No. for orders for olu-minium	For insulator. with tongue diameter mm	appr inch	Far rape diameter mm	appr. inch.	Length af coiling band mm	appr. inches	Weight 1 piece approx. kg	lbs
121603	121703	11	$^7/_{16}$	5,1– 8,1	$^{13}/_{64}$–$^5/_{16}$	550	22	1,27	$2^3/_4$
121607	121707	11	$^7/_{16}$	8,2–11,6	$^{21}/_{64}$–$^{29}/_{64}$	800	32	1,57	$3^1/_2$
121612	121712	11	$^7/_{16}$	11,7–15	$^{15}/_{32}$–$^{19}/_{32}$	1200	48	2,4	$5^1/_4$
115603	115703	16	$^5/_8$	5,1– 8,1	$^{13}/_{64}$–$^5/_{16}$	550	22	1,53	$3^1/_2$
115607	115707	16	$^5/_8$	8,2–11,6	$^{21}/_{64}$–$^{29}/_{64}$	800	32	1,85	$4^3/_{16}$
115612	115712	16	$^5/_8$	11,7–15	$^{15}/_{32}$–$^{19}/_{32}$	1200	48	2,76	6
115618	115718	16	$^5/_8$	15,1–19,2	$^{19}/_{32}$–$^3/_4$	1600	64	3,15	7
115630	115730	16	$^5/_8$	19,3–24,2	$^3/_4$–$^{15}/_{16}$	2200	88	4,17	$9^1/_4$
117618	117718	20	$^{25}/_{32}$	15,1–19,2	$^{19}/_{32}$–$^3/_4$	1600	64	3,43	$7^3/_4$
117630	117730	20	$^{25}/_{32}$	19,3–24,2	$^3/_4$–$^{15}/_{16}$	2200	88	4,35	$9^3/_4$
117650	117750	20	$^{25}/_{32}$	24,3–29	$^{31}/_{32}$–$1^1/_8$	2800	112	6,17	$13^1/_2$

Protective horns*)

with short balt for fastening ot the obove suspension terminals

No. for orders	For insulators with tongue diameter mm	appr. inch.	For suspensions terminals No.		Weight 1 piece approx. kg	lbs.
349514	11	$^7/_{16}$	121603–612	121703–712	0,27	$^1/_2$
359514	16	$^5/_8$	115603–630	115703–730	0,98	$2^1/_4$
359514	20	$^{25}/_{32}$	117618–650	117718–750	0,98	$2^1/_4$

Diograms on request

*) Jllustrations on request

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SUSPENSION TERMINALS

made of malleable cast iron or steel
fire-zinced

Pendulous suspension terminals with long tongue socket
suitable for the fastening of protective fittings

No. for orders for copper	No. for orders for aluminium	For insulators with tongue diameter mm	For insulators with tongue diameter inch.	For rope diameter mm	For rope diameter appr. inch.	Length of coiling band mm	Length of coiling band appr. inch.	Weight 1 piece approx. kg	Weight 1 piece approx. lbs
119603	119703	16	5/8	5,1– 8,1	13/64–5/16	550	22	1,88	4 3/16
119607	119707	16	5/8	8,2–11,6	21/64–29/64	800	32	2,17	4 3/4
119612	119712	16	5/8	11,7–15	15/32–19/32	1200	48	3,13	7
119618	119718	16	5/8	15,1–19,2	19/32–3/4	1600	64	3,53	7 3/4
119630	119730	16	5/8	19,3–24,2	25/32–15/16	2200	88	4,47	10
	119750	16	5/8	24,3–29	31/32–1 1/8	2800	112	6,35	14
120618	120718	20	25/32	15,1–19,2	19/32–3/4	1600	64	3,78	8 1/2
120630	120730	20	25/32	19,3–24,2	25/32–15/16	2200	88	4,67	10 1/2
	120750	20	25/32	24,3–29	31/32–1 1/8	2800	112	6,53	14 1/2

Pendulous suspension terminals with release mechanism and guide pulley*)

No. for orders for copper	No. for orders for aluminium	For insulators with tongue diameter mm	For insulators with tongue diameter appr. inch.	For rope diameter mm	For rope diameter approx. inch.	Length of coiling band mm	Length of coiling band appr. inch.	Weight 1 piece approx. kg	Weight 1 piece approx. lbs.
126603	126703	11 and 16	7/16 and 5/8	5,1– 8,1	13/64–5/16	500	19 3/4	3,68	8 1/4
126607	126707	11 and 16	7/16 and 5/8	8,2–11,6	21/64–29/64	800	32	4,03	9
126612	126712	11 and 16	7/16 and 5/8	11,7–15	15/32–19/32	1200	48	4,39	9 3/4
126618	126718	16 and 20	5/8 and 25/32	15,1–19,2	19/32–3/4	1600	64	4,63	10 1/2
	126730	16 and 20	5/8 and 25/32	19,3–24,2	25/32–15/16	2200	88	5,8	12 3/4
	126750	16 and 20	5/8 and 25/32	24,3–29	31/32–1 1/8	2800	112	6,66	14 3/4

Fitting tongue sockets on request

Supplementary clamps

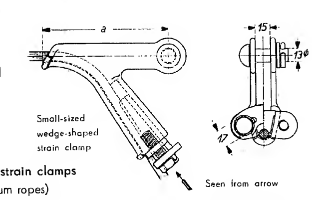
No. for orders when wanted with brass linings	No. for orders when wanted with aluminium linings	For insulators with tongue diameter	For rope diameter mm	For rope diameter appr. inch	Number of stud bolts	Weight brass 1 piece approx. kg	Weight brass 1 piece approx. lbs	Weight aluminium 1 piece approx. kg	Weight aluminium 1 piece approx. lbs.
182206	182306	—	5,1– 6,5	13/64–1/4	1	0,2	1/2	0,13	1/4
182208	182308	—	6,6– 8,1	17/64–5/16	1	0,2	1/2	0,13	1/4
182210	182310	—	8,2–10	21/64–25/64	2	0,41	1	0,29	3/4
182211	182311	—	10,1–11,6	13/32–29/64	2	0,41	1	0,29	3/4
182214	182314	—	11,7–14,7	15/32–19/32	2	0,68	1 1/2	0,47	1 1/4
182217	182317	—	14,8–17,5	19/32–11/16	3	1,13	2 1/2	0,77	1 3/4
	182319	—	17,6–19,5	11/16–25/32	3			0,77	1 3/4
	182322	—	19,6–22	25/32–7/8	3			1,38	3
	182325	—	22,1–24,5	7/8–31/32	3			1,38	3

*) These suspension terminals with release mechanism are not suitable for the attachment of protective fittings.

Fastening couplers on request
Diagrams on request
Jllustrations on request

STRAIN CLAMPS

of malleable cast iron or steel
fire-zinced



Small-sized wedge-shaped strain clamp

Small-sized wedge-shaped strain clamps
(not suitable for steel aluminium ropes)

No. for orders for copper	No. for orders for aluminium	For insulators with tongue Ø mm	For insulators with tongue Ø appr. inch.	For rope section	For rope diameter mm	For rope diameter appr. inch.	Weight for copper 1 piece appr. kg	Weight for copper 1 piece appr. lbs.	Weight for aluminium 1 piece appr. kg	Weight for aluminium 1 piece appr. lbs.
130600		11	7/16	10□	4,1	5/32	0,9	2		
130601		11	7/16	16□	5,1	13/64	0,9	2		
130602	130702	11	7/16	25□	6,3	1/4	0,9	2	0,82	1 3/4
130603	130703	11	7/16	35□	7,5	19/64	0,9	2	0,82	1 3/4
130605	130705	11	7/16	50□	9	23/64	0,9	2	0,82	1 3/4
130607	130707	11	7/16	70□	10,5	7/16	0,9	2	0,82	1 3/4
	130709	11	7/16	95□	12,5	1/2			0,82	1 3/4

No. for orders for steel aluminium ropes with a strength up to 70 kg/mm²	For insulators with tongue Ø mm	For insulators with tongue Ø appr. inch.	For rope section	For rope diameter mm	For rope diameter appr. inch.	Weight 1 piece approx. kg	Weight 1 piece approx. lbs.
130501	11	7/16	16□	5,1	13/64	0,9	2
130502	11	7/16	25□	6,3	1/4	0,9	2
130503	11	7/16	35□	7,5	19/64	0,9	2
130505	11	7/16	50□	9	23/64	0,9	2
130507	11	7/16	70□	10,5	7/16	0,9	2

Standard wedge-shaped strain clamps*) (not suitable for steel aluminium ropes)

No. for orders for copper	No. for orders for aluminium	For insulators with tongue Ø mm	For insulators with tongue Ø appr. inch.	For rope section	For rope diameter mm	For rope diameter appr. inch	Weight for copper 1 piece appr. kg	Weight for copper 1 piece appr. lbs	Weight for aluminium 1 piece appr. kg	Weight for aluminium 1 piece appr. lbs.
134602	134702	16	5/8	25□	6,3	1/4	1,26	2 3/4	1,18	2 1/2
134603	134703	16	5/8	35□	7,5	19/64	1,26	2 3/4	1,18	2 1/2
134605	134705	16	5/8	50□	9	23/64	1,26	2 3/4	1,18	2 1/2
134607	134707	16	5/8	70□	10,5	7/16	1,26	2 3/4	1,18	2 1/2
134609	134709	16	5/8	95□	12,5	1/2	1,65	3 3/4	1,48	3 1/4
134612	134712	16	5/8	120□	14	9/16	1,65	3 3/4	1,48	3 1/4
134615	134715	16	5/8	150□	15,8	5/8	2,33	5	2,15	4 3/4
134618	134718	16	5/8	180□	17,5	11/16	2,33	5	2,15	4 3/4

No. for orders for steel aluminium ropes with a strength up to 70 kg/mm²	For insulators with tongue Ø mm	For insulators with tongue Ø appr. inch.	For rope section	For rope diameter mm	For rope diameter appr. inch.	Weight 1 piece approx. kg	Weight 1 piece approx. lbs.
134502	16	5/8	25□	6,3	1/4	1,3	2 3/4
134503	16	5/8	35□	7,5	19/64	1,3	2 3/4
134505	16	5/8	50□	9	23/64	1,3	2 3/4
134506	16	5/8	70□	10,5	7/16	1,3	2 3/4

Electric arc protective fittings for strain chains are fastened to the couplers
Diagrams on request
*) Jllustrations on request

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STRAIN CLAMPS

of malleable cast iron or steel
fire-zinced

Conic strain clamps
with outgoing steel core

No. for orders	For insulat. with tongue ∅ mm	appr. inch.	For diameter of steel alu rope mm	appr. inch.	Guaranteed break. load mm	appr. cwts.	Coiling band length mm	appr. inch.	Weight of 1 piece appr. kg	lbs
151022	16	5/8	20,5–22,2	13/16–7/8	8500	188	800	32	6,2	13 1/2
151029	20	25/32	22,5–29	7/8–1 1/8	12000	265	1200	48	10	22
151129	34	1 3/8	22,5–29	7/8–1 1/8	18000	397	1200	48	11,9	26 1/2

Strain eyes with tongue socket

No. for orders	For insulators with tongue ∅ mm	appr. inch.	For solid ropes (section)	For steel aluminium ropes (section)	For rope diameter mm	appr. inch.	Guaranteed break. load kg	appr. cwts.	Weight of 1 piece appr. kg	lbs
135512	11	7/16	– 150 □	– 120 □	–16	5/8	3500	77	0,47	1
136512	16	5/8	– 150 □	– 120 □	–16	5/8	6500	144	0,7	1 1/2

Strain eyes with fork-shaped strap

No. for orders	For insulators with tongue ∅ mm	appr. inch.	For solid ropes (section)	For steel aluminium ropes (section)	For rope diameter mm	appr. inch.	Guaranteed break. load kg	appr. cwts.	Weight of 1 piece appr. kg	lbs.
136522	16	5/8	– 150 □	– 120 □	–16	5/8	6500	144	0,78	1 3/4

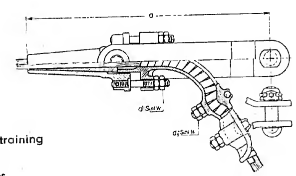
Strain pulleys

No. for orders	For insulators with tongue ∅ mm	appr. inch.	For solid ropes (section)	For steel aluminium ropes (section)	For rope diameter mm	appr inch	Guaranteed break. load kg	appr. cwts.	Weight of 1 piece appr. kg	lbs.
138512	16	5/8	– 150 □	– 120 □	–16	5/8	8500	188	2,7	6
138520	16	5/8	– 300 □	– 300 □	–24	15/16	8500	188	5,9	13 1/4
138525	20	25/32	– 400 □	– 28∅	–28	1 1/8	12000	265	10	22
138530	24	15/16	– 225 □	– 33∅	–33	1 5/16	18000	397	16,3	36

Electric arc protective fittings for strain chains are fastened to the couplers
Diagrams on request
*) Jllustrations on request

STRAIN CLAMPS

made of malleable cast iron
or steel
fire-zinced



Conic strain clamps with re-straining arrangement
for copper or aluminium ropes

No. for orders for copper	for aluminium	For insulators with tongue diameter mm	inch.	For rope section	∅ mm	appr. inch.	Number of caps	Length of coiling band mm	appr. inch.	Weight of 1 piece for copper approx. kg	lbs	for alu approx. kg	lbs.
147601		11	7/16	16 □	5,1	13/64	1	400	16	1,8	4		
147602	147702	11	7/16	25 □	6,3	1/4	1	400	16	1,8	4	1,75	3 3/4
147603	147703	11	7/16	35 □	7,5	19/64	1	400	16	1,8	4	1,75	3 3/4
147605	147705	11	7/16	50 □	9	23/64	1	550	22	2,4	5 1/4	2,4	5 5/16
147607	147707	11	7/16	70 □	10,5	7/16	1	550	22	2,4	5 1/4	2,4	5 5/16
	147709	11	7/16	95 □	12,5	1/2	1	1000	40			3,05	6 3/4
	147712	11	7/16	120 □	14	9/16	1	1000	40			3,05	6 3/4
144602	144702	16	5/8	25 □	6,3	1/4	1	400	16	2,78	6	2,61	5 3/4
144603	144703	16	5/8	35 □	7,5	19/64	1	400	16	2,78	6	2,61	5 3/4
144605	144705	16	5/8	50 □	9	23/64	1	550	22	3,29	7 1/4	3,17	7
144607	144707	16	5/8	70 □	10,5	7/16	1	550	22	3,29	7 1/4	3,17	7
144609	144709	16	5/8	95 □	12,5	1/2	1	1000	40	4,13	9 1/4	3,96	8 1/4
144612	144712	16	5/8	120 □	14	9/16	1	1000	40	4,13	9 1/4	3,96	8 1/4
144615	144715	16	5/8	150 □	15,8	5/8	1	1400	56	5,63	12 1/4	5,35	11 3/4
144618	144718	16	5/8	185 □	17,5	11/16	1	1400	56	5,63	12 1/4	5,35	11 3/4
	144724	16	5/8	240 □	20,3	25/32	1	1800	72			8,2	18
	144730	16	5/8	300 □	22,5	7/8	1	1800	72			8,2	18

For steel ropes of strength up to 120 kg/mm^2

No. for orders	F. insulators with tongue diameter		For rope section	diameter mm	approx. inch.	Number of caps	Length of coiling band mm	Weight of 1 piece approx. kg	lbs.
144502	16	5/8	25 □	6,3	1/4	1	—	3,29	7 1/4
144503	16	5/8	35 □	7,5	19/64	1	—	3,29	7 1/4
144505	16	5/8	50 □	9	23/64	1	—	4,13	9 1/4
144507	16	5/8	70 □	10,5	7/16	1	—	4,13	9 1/4
144509	20	25/32	95 □	12,5	1/2	1	—	6,7	14 3/4
144512	20	25/32	120 □	14	9/16	1	—	8,2	18

Couplers, suitable for fastening of protective fittings, and fitting tools on request.
Diagrams on request.

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STRAIN CLAMPS

of malleable cast iron or steel

fire-zinced

for steel aluminium ropes 1 : 6

No. for orders	For insulators with tongue diameter mm	inch.	For rope nominal value	∅ mm	appr. inch.	Number of caps	Length of coiling bond mm	appr. inch.	Weight of 1 piece approx. kg	lbs.
149401	11	7/16	16/25	5,4	7/32	1	400	16	1,8	4
149402	11	7/16	25/4	6,8	17/64	2	550	22	2,05	4 1/2
149403	11	7/16	35/6	8,1	5/16	2	550	22	2,05	4 1/2
149405	11	7/16	50/8	9,6	3/8	2	800	32	2,61	5 3/4
149407	11	7/16	70/12	11,6	29/64	2	800	32	2,61	5 3/4
146401	16	5/8	16/25	5,4	7/32	1	400	16	2,73	6
146402	16	5/8	25/4	6,8	17/64	2	550	22	2,98	6 1/2
146403	16	5/8	35/6	8,1	5/16	2	550	22	2,98	6 1/2
146405	16	5/8	50/8	9,6	3/8	2	800	32	3,54	7 3/4
146407	16	5/8	70/12	11,6	29/64	2	800	32	3,54	7 3/4
146409	16	5/8	95/15	13,4	17/32	2	1200	48	4,4	9 3/4
146412	16	5/8	120/21	15,7	5/8	3	2000	80	6,48	13 1/2
146415	16	5/8	150/25	17,3	11/16	3	2000	80	6,48	13 1/2
147418	16	5/8	185/32	19,2	3/4	3	2000	80	6,48	13 1/2
146421	16	5/8	210/36	20,5	13/16	3	2600	104	7	15 1/2
146424	16	5/8	240/40	21,7	27/32	3	2600	104	7	15 1/2

for steel aluminium ropes 1 : 4 according to DIN 48204 or Hiller

No. for orders	For insulators with tongue diameter mm	inch.	For rope nom. value DIN 48204	Hiller No.	∅ mm	oppr. inch.	Number of caps	Length of coiling bond mm	oppr. inch	Weight of 1 piece approx. kg	lbs.
149103	11	7/16	—	35	11,2	7/16	2	800	32	2,61	5 3/4
149105	11	7/16	—	50	14	9/16	2	1200	48	3,5	7 3/4
146103	16	5/8	—	35	11,2	7/16	2	800	32	3,54	7 3/4
146105	16	5/8	—	50	14	9/16	2	1200	48	4,4	9 3/4
146107	16	5/8	125/29	70	16,1	5/8	3	2000	80	6,48	13 1/2
146109	16	5/8	170/40	95	18,9	3/4	3	2000	80	6,48	13 1/2
146112	16	5/8	210/50	120	21	13/16	3	2600	104	7	15 1/2

Couplers, suitable for fastening of protective fittings, and fitting tools on request.

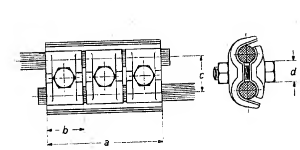
Diagrams on request.

Jllustrations on request.

CURRENT CLAMPS

Current clamps with caps made of steel

fire zinced, with plate linings of copper or aluminium



No. for orders for copper	for aluminium	For rope diameter mm	approx. inch.	For rope section mm²	approx. inch.²	Weight 1 piece approx. for copper kg	lbs.	f. aluminium kg	lbs.
170603	170703	6,3- 8,1	1/4-5/16	25-35	1-1 3/8	0,56	1 1/4	0,495	1
170607	170707	8,4-11,6	21/64-29/64	50-70	2-2 3/4	0,99	2 1/2	0,822	1 3/4
170612	170712	12,4-14	1/2-9/16	95-120	3 3/4-4 3/4	1,24	2 3/4	1,08	2 1/2
170618	170718	15,7-19,2	5/8-3/4	150-185	6-7 3/8	1.78	4	1,56	3 1/2
170630	170730	19,3-24,2	3/4-15/16	240-300	9 1/2-12	2,1	4 1/2	1,8	4
	170750	24,3-29	31/32-1 1/8	400-550	16-22			2,6	5 3/4

Connections for detachable tube current clamps*)

No. for orders for copper	for aluminium	For rope diameter mm	approx. inch.	Weight 1 piece approx. for copper kg	lbs.	for aluminium kg	lbs.
165105	165305	5,1	13/64	0,415	7/8	0,13	1/4
165107	165307	6,3– 6,8	1/4–5/16	0,415	7/8	0,13	1/4
165108	165308	7,5	19/64	0,465	1	0,15	3/8
165109	165309	7,8– 9	5/16–23/64	0,465	1	0,15	3/8
165111	165311	9,3–10,5	3/8–7/16	0,465	1	0,15	3/8
	165312	11,1–11,3	7/16–29/64			0,15	3/8
165113	165313	11,6–12,5	29/64–1/2	0,550	1 1/4	0,175	3/8
165114	165314	13,1–14	33/64–9/16	0,550	1 1/4	0,175	3/8
165116	165316	15,7–16,25	5/8–21/32	0,820	1 3/4	0,26	1/2
165119	165319	17,3–18,5	11/16–23/32	0,820	1 3/4	0,26	1/2
	165320	18,9–19,2	3/4–25/32			0,26	1/2
	165321	20 –20,3	25/32–13/16			0,37	3/4
	165322	20,5–21,15	13/16–27/32			0,37	3/4
	165323	21,7	7/8			0,37	3/4
	165324	22,3–23,1	7/8–29/32			0,37	3/4
	165325	23,7–24,2	15/16–31/32			0,56	1 1/4
	165327	25,7–26,6	1–1 1/16			0,56	1 1/4
	165329	28 –28,2	1 1/8–1 3/16			0,56	1 1/4

Diagrams on request

*) Jllustrations on request

CURRENT CLAMPS

Accessories to connect the afore-said clamp parts

No. for orders		Approx. weight of 1 piece kg	oz.
165535	Set of bolts with spring washers to connect 2 clamp parts with s = 7 mm	0,28	10
165545	Set of bolts with spring washers to connect 2 clamp parts with s = 7+10; 10+10; 13+10; 13+13 mm	0,3	11
165999	Cupal lining as intermediate layer for al-cu connections	0,027	1

Notching tools for tube current clamps

No. for orders	Suitable for copper clamps of the ord. Nrs.	Suitable for alumin. clamps of the ord. Nrs.	Tube Ø D mm	Tube Ø D inch	Suitable for notching pliers size	Suitable for notching pliers Order-Nr.	Appr. weight of 1 piece kg	oz.
245512	165105-107	165305-307	12	15/32	II	05526 o	0,25	8 3/4
245516	165108-111	165308-312	16	5/8	II	05526 o	0,25	8 3/4
245521	165113-114	165313-314	20,5	13/16	III	05526 o	0,25	8 3/4
246512	165105-107	165305-307	12	15/32	III	05529	0,75	26
246516	165108-111	165308-312	16	5/8	III	05529	0,75	26
246521	165113-114	165313-314	20,5	13/16	III	05529	0,75	26
246526	165116-119	165316-320	26	1 1/16	III	05529	0,75	26
246532		165321-324	32	1 1/4	III	05529	0,75	26
246537		165325-329	37	1 7/16	III	05529	0,75	26
Notching pliers on request								

Aluminium lap-jointers

No. for orders	drill hole Ø	fits rope Ø	drill hole Ø	fits rope Ø	drill hole Ø	fits rope Ø	drill hole Ø	fits rope Ø	Approx. weight of 1 piece kg	oz.
	Specification according to rope diameter and drill holes in mm									
164407	8	6,8- 7,5	9,5	7,8- 9	11	9,3-10,5	12	11,2-11,3	0,085	3
164412	13	11,6-12,5	14,5	13,1-14	—	—	—	—	0,145	5
164418	16,75	15,7-16,25	19	17,3-18,5	30	18,9-19,2	---	—	0,23	8
164430	21	20 -20,3	22	20,5-21	23	21,7-22,2	24	22,5-23,1	0,4	14
164450	25	24,2	27,5	25,7-26,6	29,5	22	---	—	0,68	24

Notching tools for lap-jointers

No. for orders	Suitable for lap-jointers of order No.	Profile measures of the lap-jointers mm	Profile measures appr. inch	Suitable for notching gauge size	Suitable for notching gauge Order Nr.	Appr. weight of 1 piece kg	oz.
247516	164407	16 × 23,5	5/8 × 15/16	III	05529	0,75	26
247521	164412	20,5 × 29	13/16 × 1 1/8	III	05529	0,75	26
247526	164418	26,5 × 36,5	1 1/16 × 1 7/16	III	05529	0,75	26
247532	164430	32 × 43	1 1/4 × 1 11/16	III	05529	0,75	26
247537	164450	37 × 48	1 7/16 × 1 7/8	III	05529 *)	0,75	26
Notching pliers on request							

*) For the notching gauge of order No. 247 537, the lower part of the notching gauge has to be overworked.

Illustrations on request

Diagrams on request

COUPLERS (PASS PIECES)

Suspension eyes

Tongue sockets

Double eyes

Double tongues

Extension straps

Strain bows

Shackles and eyes

VOLTAIC ARC PROTECTIVE FITTINGS

Protective Horns

for cap- and solid core-insulators

Protective Horns

with short bolt to be fastened to pendulous suspension terminals

with short tongue socket

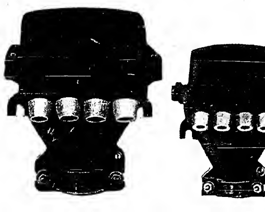
Protective Horn Crosses

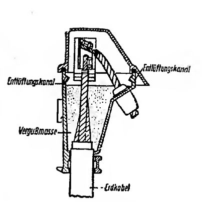
for cap- and solid core-insulators

Protective Horn Crosses

for long rod insulators

All details for these pieces and fittings on request





Entlüftungskanal = Air-relief channel
Vergußmasse = Cast-in material compound
Erdkabel = Earth cable

IKA POLE TERMINALS

for 16 to 150 qmm

For one- and multi-line cables up to 1000 volts. Made of cast iron.
For the transient from earth cable to overhead line.
When ordering, please state number of conductors and cross-section.

The terminals have porcelain insulated clamps which are situated in a special clamp room above the insulation spot. By means of this arrangement, the clamps are at all times – also during operation – well accessible and under control. The terminals have furthermore air-relief channels which prevent the gathering of condenser water at variable temperatures.
Earthing is possible over inner and outer ground clamps.

Designs:

1. Casing for 16 to 50 qmm
   Height 248 mm (about $9^3/_4$ inch.)
   Width 190 mm (about $7^1/_2$ inch.)
   Depth 155 mm (about $6^1/_8$ inch.)
2. Casing for 70 to 150 qmm
   Height 300 mm (about $11^3/_4$ inch.)
   Width 265 mm (about $10^1/_2$ inch.)
   Depth 180 mm (about 7 inch.)

No. for orders	Design Clamps and terminals for cross-sections	Approx. weight kg	Approx. weight lbs.
125–Z 1	16– 25 qmm 35– 50 qmm	5	11
124–Z 1	70– 95 qmm 120–150 pmm	10	22

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LAMPS AND LIGHTINGS

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Lamps for dwelling and club rooms . . . a
Ceiling lamps, chandeliers, pendulum lamps . . . a 1
Pedestal lamps and table lamps . . . a 2
Other lamps . . . a 3

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Lamps for working rooms . . . b 1
Lamps for working places . . . b 2
Stage lamps, Effect lamps . . . b 3
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Outdoor lamps, reflector lamps . . . b 6

Electric hand lamps . . . c
Pocket- or flash-lamps . . . c 1
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Other lamps . . . d
Phototype arc lamps . . . d 1
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Accessories for lamps . . . e
Lamp plate holders, ceiling rosettes . . . e 1
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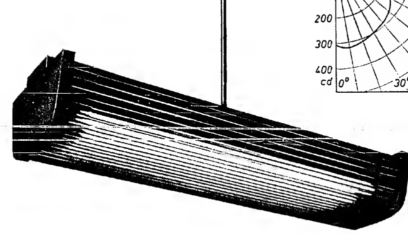
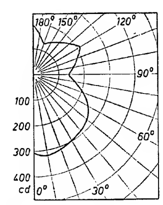




IKA SUSPENDED LUMINESCENCE LAMPS

No. 48537, 48538 and 48520

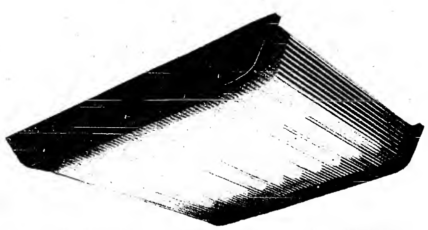
A uniform light is distributed.

Application:

For general illumination of any kind of interior rooms, offices and administration rooms, working rooms, corridors etc. with ceilings and walls of white and bright colours.
Wooden frame, light-coloured oak or elm in natural colours; luminescence lamps with glass tube casing. With incorporated choking coil and fitted lead wires.
Style of enclosure A.

No. for orders	Equipment	Approx. dimensions						Weight about	
		Height		Length		Width			
		cm	inch.	cm	inch.	cm	inch.	kg	lbs.
48537	1 × HN 120	100	40	110	44	15	6	5	11
48538	2 × HN 120	100	40	110	44	24	10	6,5	14,3
48520*)	3 × HN 120	110	44	110	44	30	12	10	22

*) Also as ceiling lamp No. 48519 without pendulum tube. Height about 20 cm. Weight about 8.5 kg

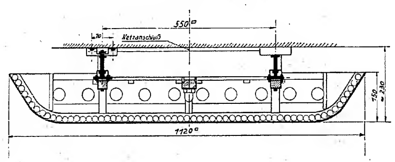


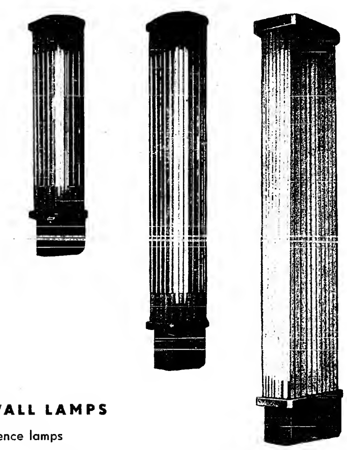
IKA LARGE-SURFACE CEILING LIGHTING WITH LUMINESCENCE LAMPS

No. 48541

Distribution of light: Direct light
Application: For general illumination of indoor rooms, offices, exhibition rooms etc.
Design: Wooden frame, light-coloured oak or elm in natural colours.
Luminescence lamps with glass tube casing. With incorporated choking coils in the air-relieved choking box, and with fitted lead wires.
Style of enclosure: A

No. for orders	Equipment	Approx. dimensions						Weight about	
		Height		Length		Width			
		cm	inch.	cm	inch.	cm	inch.	kg	lbs.
48541	10 × HN 120	22	9	110	44	110	44	75	162





IKA WALL LAMPS

Luminescence lamps

No. 48516, 48515 and 48523

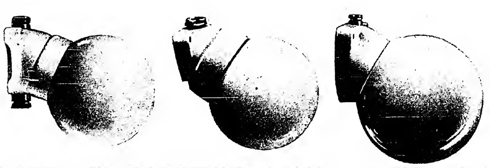
Distribution of light: Direct light
Design: Similar to the pendulum lamps 48537/38
Style of enclosure A

No. for orders	Equipment	Approx. dimensions						Weight about	
		Reach		Height		Width			
		cm	inch.	cm	inch.	cm	inch.	kg	lbs.
48516	1 × HN 50	13	5	68	27	16	6	3,5	$7^3/_4$
48515	1 × HN 80	13	5	95	38	16	6	4	$8^3/_4$
48523	2 × HN 120	12	5	120	48	28	11	6	$13^1/_4$

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK

IKA PORCELAIN WALL LAMPS

with oblique porcelain base and stuffing boxes



1260 Kab
1060 Kab

1060 Kab 2
1061 Kab 2
1062 Kab 2

1061 Kab
1062 Kab

Design:

Kob = 1 stuffing box, Kab 2 = 2 stuffing boxes
Style of enclosure B 2. **Without** glass

No. for orders	Watts	Glass thread	Weight about kg	Weight about lbs.
1260 Kab	40	A 74,5	0,42	$^7/_8$
1060 Kab	60	A 84,5	0,50	$1^1/_8$
1060 Kab 2			0,85	$1^7/_8$
1061 Kab	100	A 99	0,77	$1^5/_8$
1061 Kab 2			0,89	2
1062 Kab	200	A 123,5	1,31	$2^7/_8$
1062 Kab 2			1,65	$3^5/_8$

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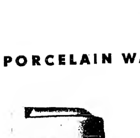
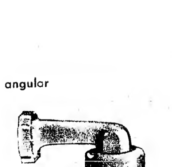
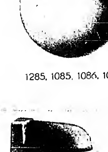
IKA PORCELAIN WALL LAMPS, angular



1285, 1085, 1086, 1087



1196, 1296



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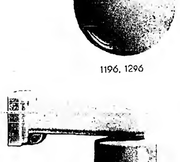

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Design: Entrance of tube can be broken out. Style of enclosure A. **Without** glass.
The reaches stated in the table are measured to the middle of the lamps.

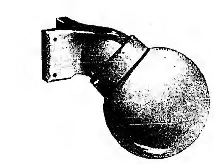
No. for orders	Watts	Reaches about		Glass thread	Weight about	
		cm	inch.		kg	lbs.
1285	40	8,5	$3\frac{1}{2}$	A 74,5	0,4	$\frac{7}{8}$
1296	40	14,5	6	A 74,5	0,5	1
1085	60	10	4	A 84,5	0,68	$1\frac{3}{8}$
1196	60	14,5	6	A 84,5	0,55	1
963	60	17	7	A 84,5	0,75	$1\frac{1}{2}$
013.3	60	8,5	$3\frac{1}{2}$	A 84,5	0,64	$1\frac{1}{4}$
013.3/1*)	60	8,5	$3\frac{1}{2}$	A 84,5	0,63	$1\frac{1}{4}$
1086	100	11,5	$4\frac{1}{2}$	A 99	1,2	$2\frac{1}{2}$
1087	200	14	6	A 123,5	1,76	$3\frac{1}{2}$

*) These lamps are for front side connection to the supply line. No. 013.3 is moreover equipped with metal thread E 27 and safety guard against touch according to IFK.

IKA PORCELAIN WALL LAMPS

for fixing to corners

Design:
No. 1160, 1161 oblique
Style of enclosure A
Without glass



1160, 1161

Design:
No. 1091 angular
Style of enclosure A. **Without** glass
No. 1091 Kab angular
Style of enclosure B 2. **Without** glass

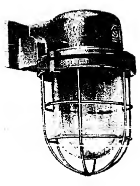
1091 Kab

The reaches stated in the table are measured to the middle of the lamps.

No. for orders	Watts	Reach about		Glass thread	Weight about	
		cm	inch.		kg	lbs.
1160 1161	60 100	12,5 17	5 7	A 84,5 A 99	0,7 1,1	$1\frac{1}{2}$ $2\frac{1}{2}$
1091 1091 Kab*)	60	9	$3\frac{1}{2}$	A 84,5	0,75 0,88	$1\frac{5}{8}$ 2

*) Kab = With one stuffing box for cable-like lead from above.

IKA WALL LAMPS



1490 N/1

No. 1490 N

Distribution of light: Mostly direct light

Design:
Lamp case of cast light metal, grey varnished, with protective basket and transparent glass. Terminal for earthing. /1./2./3 = with 1, 2 or 3 stuffing box entrances Pg. 16

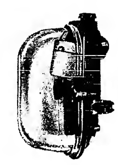
Style of enclosure C

No. for orders	Watts	Dimensions about						Weight about	
		Height		Diameter		Reach			
		cm	inch.	cm	inch.	cm	inch.	kg	lbs.
1490 N/1									
1490 N/2	60	20,5	8	13	5	15	6	1,9	$4^1/_4$
1490 N/3									

Including triangular socket wrench No. 01610 K

IKA CEILING AND WALL LAMPS

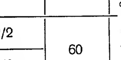
No. 2162

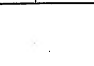


2162/3

Distribution of light: Mostly direct light

Design:
Plastic material with a stuffing box screw joint which alternatively also can be screwed into the other cable entrances with walls to be broken out.
With porcelain base E 27

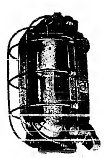
No. 2162/2  without protective basket

No. 2162/3  without protective basket

Style of enclosure B 2

No. for orders	Watts	Dimensions about						Weight about	
		Height		Length		Width			
		cm	inch.	cm	inch.	cm	inch.	kg	lbs.
2162/2	60	11	$4^1/_2$	18	7	12	5	0,78	$1^3/_4$
2162/3								0,79	$1^3/_4$

IKA CEILING AND WALL LAMPS



6041 N

No. 012.6, 6041 N

Distribution of light: Mostly direct light

Design:

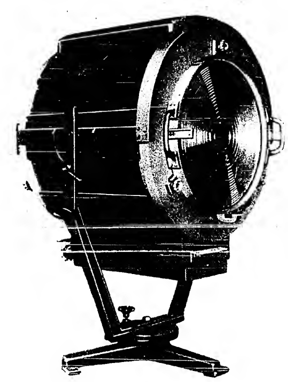
No. 012.6 } with oval lamp casing of cast light metal.
No. 6041 N }

Parts of lamp grey varnished, with protective basket and transparent glass. Earthing terminal. /1./2 = with 1 or 2 stuffing box entrances Pg 16.

Style of enclosure C.

No. for orders	Watts	Dimensions about						Weight about	
		Height		Length		Width			
		cm	inch.	cm	inch.	cm	inch.	kg	lbs.
012.6/1 012.6/2	60	11,5	$4^1/_2$	21	$8^1/_2$	12	5	1,2	$2^5/_8$
6041 N/1 6041 N/2	100	11	$4^3/_4$	24	$9^1/_2$	14	$5^1/_2$	2	$4^3/_8$

Including triangular socket wrench No. 01610 K



G & N STEP LENS HEAD-LAMPS

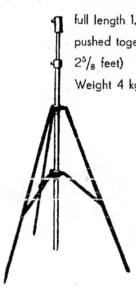
from 0,5 to 10 kW

The head-lamps have a well vented casing. The front side cast aluminium ring is bearing a flat iron ring for an-clamping of light-diaphragms, and the lens ring. Three holders on the lens ring serve for inserting diffusing screens and supplementary tubes. The lens ring and the lid on the backside are detachable. Thus the lamp and the mirror can easily be exchanged. Changing of the luminous cone is effected by adjusting the lamp and the mirror by means of a hand wheel at the rear wall of the casing. The terminals are equally arranged here. A bipolar pocket switch is incorporated laterally. The casing is slewable upwards and downwards in a bow and can be clamped fast in its supports.

G & N TRIPODS

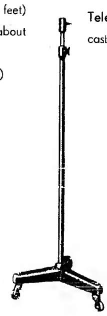
Foldable and
telescopic tripod

full length 1,75 m (about 5 feet)
pushed together 0,80 m (about $2^5/_8$ feet)
Weight 4 kg (about 10 lbs.)



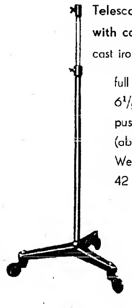
Telescopic tripod with casters
cast iron tripod

full length 2 m (about $6^1/_2$ feet)
pushed together 1,30 m (about $4^1/_4$ feet)
Weight 14 kg (about 31 lbs.)



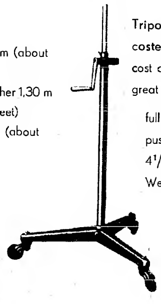
Telescopic tripod
with casters
cast iron tripod

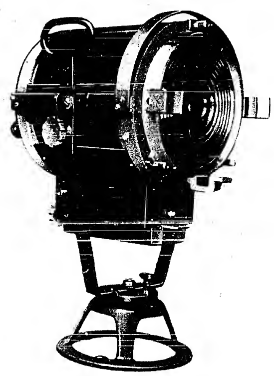
full length 2 m (about $6^1/_2$ feet)
pushed together 1,30 m (about $4^1/_4$ feet)
Weight 19 kg (about 42 lbs.)



Tripod with
costers for winding up
cast aluminium tripod
great reach

full length 2 m (about $6^1/_2$ feet)
pushed together 1,30 m (about $4^1/_4$ feet)
Weight 16 kg (about 35 lbs.)





G & H STEP LENS HEAD LAMP 0,5 kW

for episcope lamp 500 watts
globe-shaped, base Ed. 4a/27

The bow is supported by a rotary plate which is connected with the tripod by means of 17,5 mm pin. This pin serves for setting the head lamp upon tripods. The tripod has three holes for fastening it to practi-cables and the like.

Diameter of lens: 175 mm (about 7 inch.)
Diameter of mirror: 100 mm (about 4 inch.)

Total height: 45 cm (about $15^3/_4$ inch.)
Total length: 37 cm (about $14^1/_2$ inch.)
Total width: 30 cm (about 12 inch.)

Weight: 6 kg (about $13^1/_4$ lbs.)

Light-diffusion diagram overleaf.

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Light-diffusion diagram

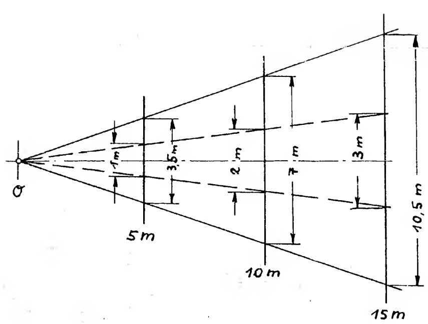
Step lens head lamp 0,5 kW

(Diameter of step lens 175 mm = 7 inch.)

Source of light:

Episcope lamp 0,5 kW/220 volts

Transparent glass bulb



Light intensity at a distance of 5 m (about $5^1/_2$ yards):

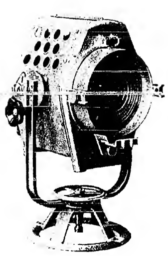
at low diffusion 2660 lux

at high diffusion 300 lux

IKA HEAD LAMP FOR LIGHTING UP FILMS

IKA STEP LENS HEAD LAMP

0,5 and 2 kW



Application:

For filming illumination in film studios, photographic studios, for special purposes such as stage and theater illumination, as well as for filming in research institutes and the like.

The step lens (zone lens according to Fresnel) is particularly suitable for producing uniformly illuminated light fields of a high illumination intensity, both in case of concentration and of diffusion.

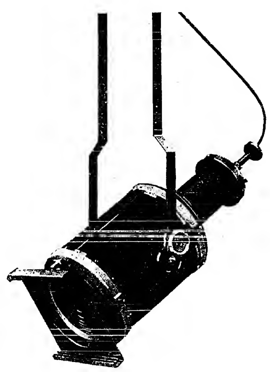
The table at foot of this sheet shows the diameters of light fields and the illumination intensities at a distance of 5 m (abt. $5^1/_2$ yds.) and the maximum light intensities of the 0,5 and 2 kW implements.

kW	Light field at a distance of 5 m (abt. $5^1/_2$ yds.) at		Maximum light intensity in decimeter² at		Jllumination intensity E in lux at a distance of 5 m (abt. $5^1/_2$ yds.) at	
	Concentration	Diffusion	Concentration	Diffusion	Concentration	Diffusion
0,5	0,6	3,5	90000	7000	3600	280
2	1,2	3,8	180000	27000	3200	1080

G & N EFFECT LIGHT

for spotlight lamp of 1000 watts

Burning position A



Upon special request the lamp will be delivered with box containing coloured panes: red, yellow, green, blue, and with protective grate.

Step lens: Diameter 200 mm, Weight 0,7 kg (about $1^1/_2$ lbs) or
Plano-convex lens: Diameter 150 mm, Weight 0,7 kg (about $1^1/_2$ lbs.)

Total length: 85 cm (about $33^1/_2$ inch.)
Total width: 32 cm (about $12^1/_2$ inch)

Total weight with lens: 7 kg (about 15 lbs.)

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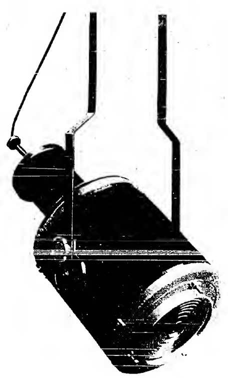


G & N EFFECT LIGHT

for spotlight lamp 2000 watts

Burning position A

Upon special request the lamp will be delivered with box containing coloured panes: red, yellow, green, blue, and with protective grate.

Step lens: Diameter 250 mm (about 10 inch), Weight 1,5 kg (about $3^1/_4$ lbs.) or

Plano-convex lens: Diameter 200 mm (8 inch.), Weight 1,5 kg (about $3^1/_4$ lbs.)

Total length: 95 cm (about 38 inch.)

Total width: 39 cm (about $15^1/_2$ inch)

Total weight with lens: 11 kg (about 24 lbs.)

G & N POINT LIGHT PROJECTOR 1 kW

for projector lamp 1000 watts, type B, with small glass bulb

The point light projector gives, at a distance of 5 m (about $5^1/_2$ yards), a circular light of 3,50 m (about $3^3/_4$ yards) which by an incorporated iris diaphragm can be reduced to the smallest point. It is equipped with contrivances for inserting masks and lantern slides 13×13 cm (5×5 inch.), as well as with a frame for inserting filters or coloured panes.

The optique can be removed from the topside, and the lamp can then be used as a lens head lamp with a plano-convex lens which is still installed at the head lamp. Before the plano-convex lens there is arranged a large box containing coloured panes and masks.

Furthermore the lens ring with the plano-convex lens can be removed, for setting before a ring with step lens for diffused and concentrated light.

This implement can be used for many different purposes.

Lux value at a distance of 5 m (about $5^1/_2$ yards) 500 lux

Total length: 65 cm (about 25 inch.)

Total height: 53 cm (about 21 inch.)

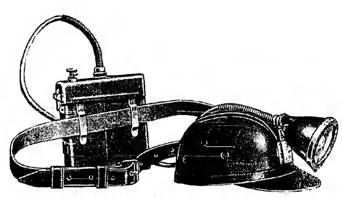
Total width: 32 cm (about $12^1/_2$ inch.)

Total weight: 13 kg (about $28^1/_2$ lbs.)

Tripod with casters: Full length 2 m (about 6 feet), pushed together 1,30 m (about $4^1/_2$ feet)

Weight: 14 kg (about 31 lbs.)

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



ELECTRIC GLF HEAD LAMP (CAP LAMP)

Type 830 cr, locking by magnet

Type 830 crs, locking by key

With nickel-cadmium accumulator

Firedamp-proof design

Height 178 mm
= abt. 7 inches

Capacity 11 amp-hours

Weight 3 kg
= abt. 7 lbs.

Burning time 11 hours

Incandescent lamp 2,5 volts/1 amp.

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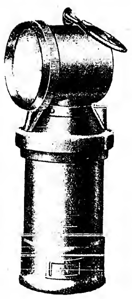
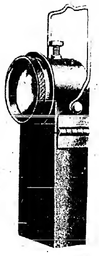


ELECTRIC GLF REFLECTOR LAMP

Type 950 afr, locking by magnet
Type 950 afrb, locking by key

With nickel-cadmium accumulator
Firedamp-proof design.

Height 330 mm (abt. 13 inch.)
Capacity 26 amp-hours
Weight 5,9 kg (abt. 13 lbs.)
Burning time 16 hours
Incandescent lamp 2,5 volts/1,75 amp

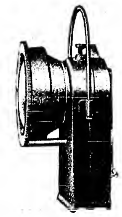


ELECTRIC GLF HAND LAMP

Type 624 r, locking by magnet
Type 624 rb, locking by key

With nickel cadmium accumulator
Firedamp-proof design

Height 213 mm (abt. $8^1/_2$ inch.)
Capacity 6 amp hours
Weight 1,690 kg (abt. $3^3/_4$ lbs.)
Burning time 12 hours
Incandescent lamp 2,5 volts/0,5 amp.

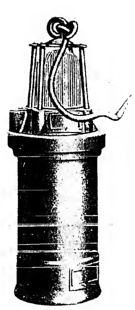


SMALL ELECTRIC GLF HAND LAMP

Typ eob, locking by magnet
Typ eo, locking by key

With nickel-cadmium accumulator
Firedamp-proof design

Height 150 mm (about 6 inch.)
Capacity 4 amp-hs.
Weight 1,2 kg (about $2^5/_8$ lbs.)
Burning time 8 hours
Incandescent lamp 2,5 volts/0,5 amp.

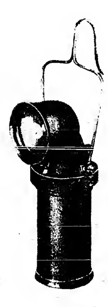


ELECTRIC
GLF LAMP FOR MINERS

Typ 950 fr, locking by magnet
Typ 950 frb, locking by key

With nickel-cadmium accumulator
Firedamp-proof design

Height 323 mm (about $12^7/_8$ inch)
Capacity 28 amp-hs.
Weight 5,4 kg (about $11^7/_8$ lbs.)
Burning time 16 hours
Incandescent lamp 2 volts/1,75 amp.



ELECTRIC
GLF MINE SURVEYOR'S LAMP

Type 607 as, locking by key
brass design, far mine-surveying and other surveying purposes

With lead occumulatar
Firedamp-proof design

Height 210 mm (about $8^3/_8$ inch.)
Capacity 7 amp-hs.
Weight 2 kg (abaut $4^1/_2$ lbs.)
Burning time 10 hours
Incandescent lamp 2 valts/0,7 amp.

IKA HAND AND POCKET FLASH-LAMP CASINGS

The casings are made of iron, brass or aluminium sheet, unless other material results from the type designation.

The surfaces of the casings differ as follows:

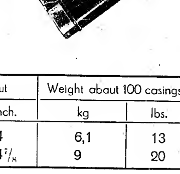
b = all varnished   d = body varnished, caps nickel-plated

The term „caps" includes the cup, the upper cap and the bottom cap.

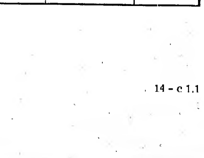
When passing your order, remember to add to the type No. also the small letter which refers to the surface finish desired.

The pocket lamp casings are delivered with incandescent lamps screwed in.

Daimon flat lamp No. 1211
for 3-cell normal batteries
Push-type contact
so-called cavalier lens
Point light incandescent lamp No. 4050



Daimon flat lamp No. 1511
far 3-cell narmal batteries
facus, push-type contoct
facett glass 40 mm ($1^5/_8$ inch.)
illumination reach 80 m (obaut 90 yards)
Point light incandescent lamp Na. 4050



No. for orders	Surface finish	Height about		Weight about 100 casings	
		mm	inch.	kg	lbs.
1211	b, d	100	4	6,1	13
1511	b, d	120	$4^7/_8$	9	20

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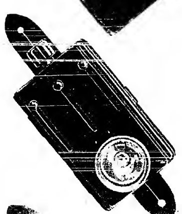
Daimon flat lamp No. 2200

for 3-cell normal batteries
Morse and fixing contact
Facet glass 40 mm ($1\frac{5}{8}$ inch.)
Point light incandescent lamp No. 4050



Daimon signal lamp No. 2234

for 3-cell normal batteries
Morse and fixing contact
Signal panes for red, green and blue light
Holder for 2 spare incandescent lamps
Facet glass 40 mm ($1\frac{5}{8}$ inch)
Point light incandescent lamp No. 4050

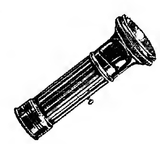
Daimon flat lamp No. 2361

for 3-cell normal batteries
Push-type contact
Facet glass 60 mm ($2\frac{3}{8}$ inch.)
Point light incandescent lamp No. 4050

No. for orders	Surface finish	Height about		Weight about 100 casings	
		mm	inch.	kg	lbs.
2200	b	125	5	10,3	$22\frac{5}{8}$
2234	b	125	5	15	33
2361	b	110	$4\frac{3}{8}$	12,5	$27\frac{1}{2}$

Daimon Miniature staff-shaped lamp No. 8042

for small staff-shaped batteries
Focus, push-type contact
Facet glass 40 mm ($1\frac{5}{8}$ inch.)
Illumination reach 70 m (about 75 yards)
Point light incandescent lamp No. 2050

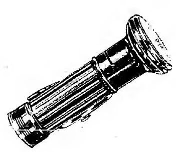


Daimon staff-shaped lamp No. 8651

for 2-cell staff-shaped batteries
Push-type contact
Facet class 50 mm (2 inch.)
Point light incandescent lamp No. 2050

Daimon staff-shaped lamp No. 9260

for 2 monocells
Morse and fixing contact
Facet glass 60 mm ($2\frac{3}{8}$ inch.)
Illumination reach 100 m (about 110 yards)
Point light incandescent lamp No. 2050



No. for orders	Surface finish	Length about		Weight about 100 casings	
		mm	inch.	kg	lbs.
8042	b, d	105	$4\frac{1}{8}$	4,9	$10\frac{3}{4}$
8651	b, d	135	$5\frac{3}{8}$	7	$15\frac{3}{8}$
9260	b, d	165	$6\frac{5}{8}$	12,5	$27\frac{1}{2}$

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Daimon staff-shaped lamp No. 9280

for 2 monocells
Morse and continuous contact
Facet glass 80 mm ($3\frac{1}{4}$ inch.)
Illumination reach 100 m (about 110 yards)
Point light incandescent lamp No. 2050

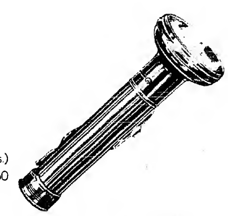
Daimon staff-shaped lamp No. 9360

for 3 monocells
Morse and continuous contact
Facet glass 60 mm ($2\frac{3}{8}$ inch.)
Illumination reach 120 m (about 130 yards)
Point light incandescent lamp No. 4050

No. for orders	Surface finish	Length about		Weight about 100 casings	
		mm	inch.	kg	lbs.
9280	b, d	170	$6\frac{3}{4}$	13,5	31
9360	b, d	225	9	14	30

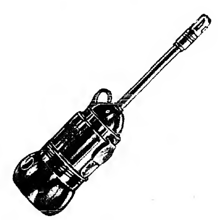
Daimon staff-shaped lamp No. 9380

for 3 monocells
Morse and continuous contact
Facet glass 80 mm ($3\frac{1}{4}$ inch.)
Jllumination reach about 200 m (220 yds.)
Point light incandescent lamp No. 4050



Daimon gas-lighter No. 9089

for 1 monocell
Spring contact
Ignition coil No. 9085



No. for orders	Surface finish	Length about		Weight about 100 casings	
		mm	inch	kg	lbs.
9380	b, c, d	240	$9\frac{1}{2}$	20,5	45
9089	d	200	8	6,5	$14\frac{1}{4}$

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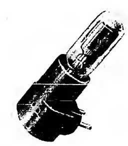
IKA POCKET FLASH-LAMP "ACCUMET"

with steel accumulator

Design:

Handy, aval-shaped casing af plastic material with steel (nickel-cadmium) accumulator, reflectar and lens, switch and charging cantacts.

Type	Incandescent lamps		Capacity	Measurements						Weight about per 100 casings	
				Length		Width		Height			
	volts	amp.	amp-hs.	mm	inch.	mm	inch.	mm	inch.	kg	lbs.
A 5	2,5	0,2	0,7	43	1 3/4	26	1	122	5	15	33



IKA CHARGING IMPLEMENT

for charging the "ACCUMET" lamp at any normal alternating current plug

Design:

Plastic casing with 2 plug pins. Series resistance and glow rectifier valve.

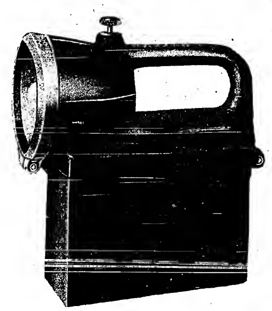
Type	Contact voltage volts	Efficiency milliamps.	Approx. weight per 100 cas. kg	lbs.
L 15	110 und 220	25 – 30	8	17 1/2

IKA DYNAMO HAND AND POCKET LAMP

Design:

Six-pole Alni-rotor drive, almost noiseless operation over tooth segment and free wheel clutch, plastic casing. Operating handle and lamp socket bright chromium-plated.

Type	Incandescent lamp with domed lens	Measurements						Weight about per 100 casings	
		Length		Width		Thickness			
		mm	inch.	mm	inch.	mm	inch.	kg	lbs.
DH 4	3,8 volts 0,07 amp.	93	$3^1/_2$	50	2	27	1	13	29

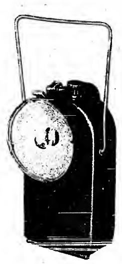


ELECTRIC GLF HAND LAMP

in plastic casing with 3-cell nickel-cadmium accumulator

Special advantages: Pleasant shape, easy attendance, always ready for use, extremely long life, lowest possible rate of self-discharge, highest luminosity, low weight. Switch for instantaneous and continuous contact.

	Small design	Large design
No. for orders	833	833a
Capacity	6 Ah	11 Ah
Burning time	12 hours	11 hours
Incandescent lamp	3,5 V/0,5 A	3,5 V/1 A
Charge	8 hours with 1,5 A	8 hours with 3 A
Height of casing	about 178 mm (7 inch.)	240 mm ($9^1/_2$ inch.)
Maximum width	about 83 mm ($3^1/_4$ inch.)	83 mm ($3^1/_4$ inch.)
Maximum length	about 185 mm ($7^1/_4$ inch.)	185 mm ($7^1/_4$ inch.)
Weight of the complete lamp	about 1,8 kg (4 lbs.)	2,8 kg ($6^1/_4$ lbs.)



SMALL ELECTRIC GLF HAND LAMP

Type 966di with toggle closure

Not firedamp-proof

With nickel-cadmium accumulator

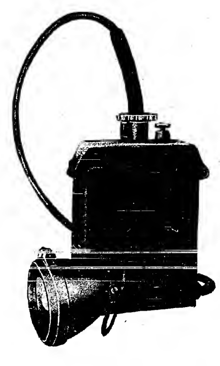
Height 150 mm (6 inch.)

Capacity 4 amp-hs.

Weight 0.9 kg (2 lbs.)

Burning time 8 hours

Incandescent lamp 2.5 volts/0.5 amp.



ELECTRIC GLF HEAD LAMP

in plastic casing

with 3-cell

nickel-cadmium accumulator

Special advantages: Practical shape, easy attendance, always ready for use, long life, lowest possible rate of self-discharge. Highest luminosity, low weight. Switch for instantaneous and continuous burning.

Particularly high safety factor; in case of breakage of the pane immediate current interruption.

	Large design	Small design
Type	834	834 A
Capacity	11 amp-hs	6 amp.-hs.
Burning time	11 hours	12 hours
Incandescent lamp	3.5 V/1 A	3.5 V/0.5 A
Charge	8 hours with 3 A	8 hours with 1.5 A
Height of casing	about 205 mm (8 inch)	about 143 mm ($5^3/_4$ inch.)
Maximum width	about 65 mm ($2^1/_2$ inch.)	about 65 mm ($2^3/_4$ inch.)
Maximum length	about 160 mm ($6^1/_4$ inch.)	about 160 mm ($6^1/_4$ inch.)
Diameter of reflector casing	about 83 mm ($3^1/_4$ inch.)	about 83 mm ($3^1/_4$ inch.)
Weight of the complete lamp	about 2.8 kg ($6^1/_8$ lbs.)	about 1.8 kg (4 lbs.)

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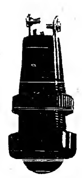
IKA SIGNALLING LAMPS


2387

No. 2387

Design:

Plastic material, for one-hole fastening, diameter of hole 25 mm, (1 inch.) with coloured lens 22 mm ($^7/_8$ inch.) in diameter (red, green etc.) for fitting to switchboards


2365

No. 2365

Design:

Plastic material, for one-hole fastening, diameter of hole 26 mm (1 inch.) with incorporated transformer for 110 or 220 volts alternating current (to be stated when passing your order)
with coloured lens 30 mm ($1^1/_4$ inch.) in diameter (red, green etc.) for fitting to switchboards

No. for orders	For	Weight about	
		kg	oz.
2387	Glow lamp E 14, 110/220 volts	0,03	1
2365	Midget lamp E 10, 4 V, 0,8 A	0,24	$8^1/_2$

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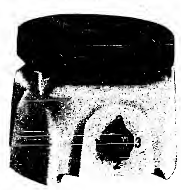
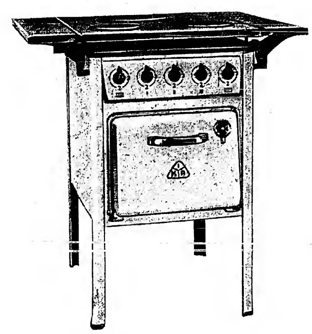


IKA SINGLE-ELEMENT HOT-PLATE

Hot-Plate EKA 18

The electric hot-plate with porcelaine case and incorporated 3-stage switch. Solid performance. Burner of special cast-iron of high strength and with uniform heat radiation. Designed for long service life.

Type	Diameter of burner mm	Diameter of burner approx. inches	Wattage approx. watts	Weight approx. kilos	Weight approx. lbs.
EKA 18	180	7	1200	4	9



IKA RANGES

Domestic Range ELH 3
The standard range with 3 burners. The burners as well as the oven's top and bottom heating elements feature 3-stage control. Front, side walls and feet are enamelled in white, top and trough in black. Door frame and handle of the oven are nickel-plated.

Size: Height 800 mm, width (minus side-plates) 500 mm, depth 590 mm. (about $31\frac{1}{2} \times 19\frac{3}{4} \times 23\frac{1}{4}$ inches)

Accessories: 1 baking-tray, 1 slip-in grill.

Please state type and voltage *).

Type	Burners			Oven			Total wattage	Weight approx.	
	Diameter		Wattage	Inside		Wattage			
	mm	approx. inches	approx. watts	mm	approx. inches	approx. watts	approx. watts	kilos	lbs.
ELH 3	145 180 200	$5^3/_4$ 7 $8^1/_2$	800 1200 1800	height 230 width 330 depth 470	9 13 $18^1/_2$	1200	5000	44	97

*) Standard voltage 120 und 220 volts.

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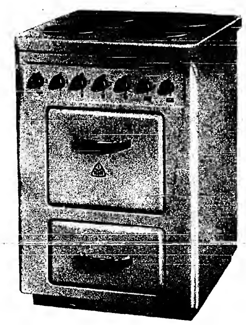

IKA ELECTRIC RANGES

Domestic Range EKCW . . .

The attractive range, available with 3 or 4 burners, meets highest requirements. The burners as well as the oven's top and bottom heating elements, and the heating compartment underneath, feature 3-stage control. The range is enamelled in white, the low base and the trough in black. Nickel-plated door handles.

Size: Height 800 mm, width 560 mm, depth 615 mm.
(about 31½ × $22^{1}/_{16}$ × 24¼ inches)

Accessories: 1 baking-tray, 1 slip-in grill.

Please state type and voltage *).

Type	Burners			Oven			Heating compartment	Total wattage	Weight approx.	
	Diameter		Wattage	Inside		Wattage				
	mm	approx. inches	approx. watts	mm	approx. inches	approx. watts	approx. watts	approx. watts	kilos	lbs.
EKCW 3	145**)	$5^{3}/_{4}$	800	height						
	180	7	1200	230	9	1200	300	5300	54	119
	220	$8^{1}/_{2}$	1800	width						
EKCW 4	145**)	$5^{3}/_{4}$	800	330	13					
	180	7	1200	depth						
	220	$8^{1}/_{2}$	1800	470	$18^{1}/_{2}$	1200	300	6500	57	125

*) Standard voltage 120 and 220 volts.

**) The burner of 145 mm diameter has been equipped with an adaptering for replacement by a burner of 220 or 180 mm diameter respectively.

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IKA ELECTRIC RANGES

Domestic Range EKBD 2 . . .
The combination with coal stove, constructed according to the continuous-burning principle and equipped with shaking grate. The 2 electric burners and the oven's top and bottom heating elements feature 3-stage control. Front, sides and feet are enamelled in white, top, trough, door frame and the interior of the oven in black. The top of the coal stove is blackened.

Size: Height 800 mm, width 880 mm, depth 590 mm
(about 31½ × 34½ × 23¼ inches)

Accessories: 1 baking-tray, 1 slip-in grill, 1 ringlifter.
Additional against extra charge:
1 oven rod, 1 frying-pan.

Please state type and voltage *).

Type	Burners			Oven			Total wattage	Weight approx.	
	Diameter		Wattage	Inside		Wattage			
	mm	approx. inches	approx. watts	mm	approx. inches	approx. watts	approx. watts	kilos	lbs.
EKBD 2 r or 1 **)	145 180	$5^3/_4$ 7	800 1200	height 230 width 330 depth 470	9 13 $18^1/_2$	1200	3200	140	308

*) Standard voltage 120 and 220 volts.
**) r = coal stove at the right, l = coal stove at the left hand side (looking at the front of the range).

IKA ELECTRIC POT

Waterpot EWD 12

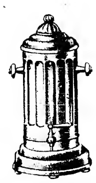
Contents 2 liters (about 3½ pints). Rapid heater, quick performance owing to an ingenious arrangement. Pot made of corrosion-proof light metal, cast in one piece. The input power amounts to 1750 watts and is decreasing to 1200 watts, due to automatic wattage control. Pot equipped with a dry-run device, to give security whenever it is left without water.

When ordering, please state type and voltage *).

Type	Contents approx.		Wattage approx.	Weight approx.	
	liters	pints	watts	kilos	lbs.
EWD 12	2	$3^1/_2$	1750/1200	1,8	4

*) Standard voltage 120 and 220 volts.

IKA COFFEE PERCOLATORS



1023

Coffee cookers 1023

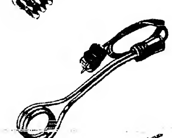
By means of these percolators, coffee-preparing becomes a pleasure. The coffee is perfectly utilized, and its flavour is fully preserved. Small quantities of water are quickly heated, spurted and evenly filtered through the ground coffee. High-gloss finish of the cookers, tinned inside, smartly styled design.

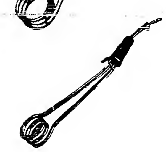
Please state type and voltage *).

Type	Contents approx.		Wattage approx.	Weight approx.	
	liters	pints	watts	kilos	lbs.
1023	1,0	$1^3/_4$	400	1,5	$3^1/_4$

*) Standard voltage 120 and 220 volts.

IKA-IMMERSION HEATERS





The immersion heater is the most economical electrical appliance, by means of which water and other liquids are quickly heated in any vessel.

Immersion heater 1042 and 1043
Nickel-plated, high-gloss finish and temperature-proof.

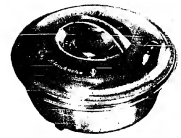
Immersion-heaters ERT 60e and ERT 100e
Dull-finish nickel-plating with suspension-hook, highly temperature-proof, owing to a new manufacturing method. These immersion-heaters are equipped with 1-m extension cords and plugs.

Immersion-heaters TS 401 and TS 475b
High-gloss nickel-plated and with suspension-hook; extra ordinarily temperature-proof.

Please state type and voltage *).

Type	Wattage approx.	Weight approx.	
	watts	kilos	oz.
TS 401	500	0,175	7
ERT 60e**)	600	0,400	$14^1/_2$
1042***)	800	0,320	12
1043***)	1000	0,330	12
ERT 100 e**)	1000	0,500	18
TS 475b	1000	0,260	9

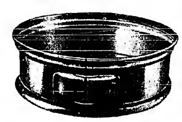
*) Standard voltage 120 and 220 volts.
**) With 3-core cable and safety plug.
***) On request with 3-core cable and safety plug.



IKA MINIATURE COOKERS

Miniature Cooker ESKK 6

The practical and approved baking and cooking device. The rim of the cover holds the electrical heating element; in the centre is an inspection glass. The aluminium basin is ideal for the baking of raised cakes, and, for cooking purposes, the cone may be removed. A 3-feet raised support prevents diversion of the heat.
Please state your voltage *).



SPRINGFORM, TYPE ESF 6

Springform ESF 6

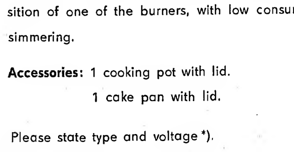
When baking tarts, bottoms of tarts, flat fruit cakes, etc., this aluminium springform is preferably used, instead of the former aluminium dish.

When ordering, please state type and voltage *).

Type	Wattage about watts	Approx. diameter of form mm	inches	Approx. weight grams	oz.
ESKK 6	500	285	11	1300	45
ESF 6	—	285	11	600	21

*) Standard voltage 120 and 220 volts.

IKA DUOTHERM



Duotherm IKD u 20

For cooking, frying, baking and an economical simmering cooking. The device, enamelled in white, is equipped with two 3-step regulated burners and with a heating-ring for baking and frying. Recessed and insulated position of one of the burners, with low consumption switch, for continued simmering.

Accessories: 1 cooking pot with lid.
1 cake pan with lid.

Please state type and voltage *).

Type	Burner			Recessed burner				Heating ring	Total wattage
	Diameter		Wattage	Diameter		Wattage	Simmering	Wattage	
	mm	appr. inch.	approx. watts	mm	appr. inch.	approx. watts	approx. watts	approx. watts	approx watts
IKD u 20	180	7	1200	145	$5^3/_4$	800	130	600	2000

Weight: approx. 17,5 kilos or 38½ lbs.

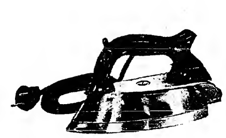
*) Standard voltage 120 and 220 volts.

IKA ELECTRIC IRONS

Iron 1003

Practical form, finest heat utilization, well-balanced weight, with high-glossed cap and polished sole plate. Length 200 mm, width 95 mm. (about 7¾ × 3¾ inches)

Iron EPHS 30



The well styled iron with switch in the handle, signal lamp, bevelled edges for easy ironing and fixed 2-m extension cord (about 2¼ yds.), plus plug. The arrangement in the handle permits an extraordinarily convenient switching-on and off in operation, the signal lamp secures at all times a visual control whether the heating element is switched on or off.

Please state type and voltage *).

Type	Wattage approx. watts	Weight approx.	
		kilos	lbs.
1003	450	3	$6^1/_2$
EPHS 30	450	3,5	$7^3/_4$

*) Standard voltage 120 and 220 volts.

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Iron EPRW 20

In form and design similar to iron EPHS 30, but, additionally, an automatic temperature control is incorporated. By means of a button at the handle-rear, it is individually adjustable to the type of fabric to be ironed, and the base of your iron automatically gets the proper heat for the fabric. The signal lamp gives visual indication of the desired heat and, thus, shows whenever the iron is ready for operation. – For AC only!

Iron 1006

Handy iron, well suited for travelling. Polished bottom, cap of high-gloss finish. To be used with each standard connection cord.
A convertible arrangement, with spring at the handle, secures the position for 220 volts operation and, thus, protects it from possible incidental destructions. 110 volts operation only after turning the convertion switch. In spite of the small consumption of 100 watts only, this No. 1006 gets the same heat as any standard househould iron. High economy is, therefore, secured.

Please state type and voltage *).

Type	Wattage approx. watts	Weight approx. kilos	Weight approx. oz.
EPRW 20	800	2	70
1006	100	0,85	30

*) Standard voltage 120 and 220 volts.

IKA STORAGE HEATERS

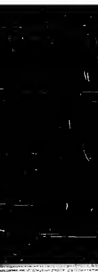
Storage Heater EHP 8

For low-pressure water heating, with temperature control. Interior jacket made of special porcelaine, the exterior jacket of steel. The heater is white enamelled.

Size: Height 640 mm, diameter 278 mm.
(Height about 25¼ inches, diameter about 11 inches).

Delivery without fittings.

Storage Heater EHNP 80 k



For low-pressure service. Facility for regulation of temperature. Interior jacket made of tinned copper, the exterior jacket of steel. The heater is white enamelled.

Size: Height 1135 mm, diameter 475 mm.
(Height about 44¾ inches, diameter about 18¾ inches).

Delivery without fittings.

Please state type, voltage and current *).

Type	Net contents approx. liters	Net contents approx. pints	Heating time approx. hours	Wattage approx. watts	Net weight approx. kilos	Net weight approx. lbs.
EHP 8	8	14	$^3/_4$	1200	12	$26^1/_2$
EHNP 80k	80	140	8	1000	58	128

*) Standard 120 and 220 volts, AC.

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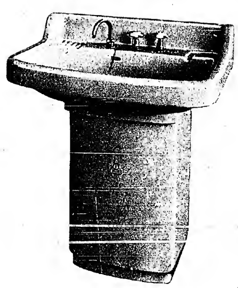


IKA STORAGE HEATERS

Lavatherm EHL 8

The porcelaine-lavatory with hot water storage underneath, for low pressure service. The interior jacket is made of special porcelaine, the exterior jacket of hard paper. The storage and the feeding and draining pipes feature porcelaine coating. Temperature control.

Size: Height (to basin-rim) 850 mm (about 33½ inches)
width 750 mm (about 29½ inches)
depth 550 mm (about 21½ inches)

Please state type, voltage and current *).

Type	Net contents of Storage approx. liters		Lavatory approx. liters		Heating time approx. hours	Wattage approx. watts	Net weight approx. kilos	
	liters	pints	liters	pints			kilos	lbs.
EHL 8	8	14	16	28	42	1200	49	108

*) Standard 120 and 220 volts, AC.

IKA HEAT PADS

Heat Pad

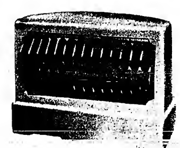
with extension cord and 3-stage cordswitch. Automatic temperature control.

Please state type and voltage *).

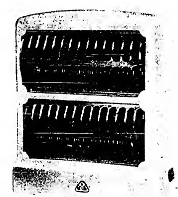
Type	Wattage approx. watts	Size of heat pad mm	approx. inch.	Weight approx. kilos	oz.
1400 G	70	300 × 400	$11^3/_4 \times 15^3/_4$	0,650	23

*) Standard voltage 120 and 220 volts.

IKA ELECTRIC RADIANT HEATERS



EWD 35 1.102



EWD 35 1.103

Ceramic case, made of special porcelaine. The polished reflector emits the heat through the wire guard.

Please state type and voltage *).

Type	Wattage approx. watts	Approx. Sizes width mm	width inches	height mm	height inches	depth mm	depth inches	Weight approx. kilos	lbs.
EWD 35 1.102	500	280	11	220	$8^1/_2$	120	$4^3/_4$	4	$8^3/_4$
EWD 35 1.103	1000	280	11	360	$14^1/_8$	150	$5^3/_4$	8	$17^1/_2$

*) Standard voltage 120 and 220 volts.

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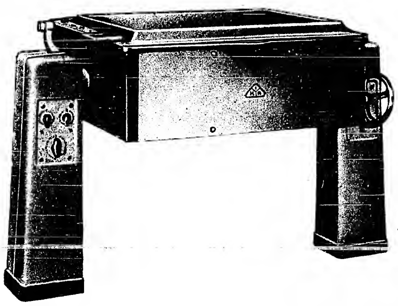


IKA TILTING FRYING-PANS

Tilting Frying-Pan GKB 80/60 k

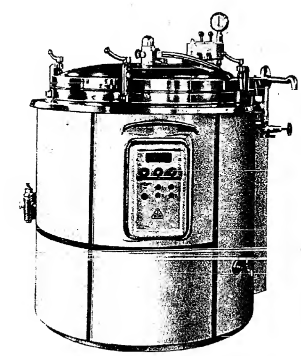
The cast-iron pan, with well-balanced aluminium lid, is supported by 2 pillars. It can be tilted by means of a hand wheel. Its case is enamelled in white, the 2 supports are white varnished. 7-stage operation is permitted by 3 switches.

Size: Height (incl. lid) approx. 1000 mm (about 39½ inches)
Width (incl. supports) approx. 1500 mm (about 59 inches)
Depth (incl. lid console) approx. 900 mm (about 35½ inches)

Please state type, voltage and current *).

Type	Size of pan-base		Wattage approx. watts	Weight approx.	
	mm	approx. inch.		kilos	Cwts.
GKB 80/60 k	800 × 600	$31^1/_2 \times 23^1/_2$	13	265	5.1.0

*) Normal voltage 220 volts, for A. C. and three-phase-current. Special voltages or currents on request.



IKA WATERBATH COOKER

Waterbath Cooker GKKW . . .

For cooking and boiling of large quantities. The performance of the 300 liter-boiler (about 525 pints) is controlled by a 2-stage switch, by a 3-stage switch for the 600 liter-boiler (about 1050 pints). The interior jacket and the lid are made of hydronalium, the outside jacket is enamelled in white.

	300 liter-boiler	600 liter-boiler
Sizes: height to boiler-rim	1070 mm (abt. 42″)	1225 mm (abt. 48¼″)
diameter of exterior jacket	1120 mm (abt. 44″)	1370 mm (abt. 54″)

Please state type, voltage and current *).

Type	Net contents approx.		Wattage approx.	Required boiling time **) approx.	Weight approx.	
	liters	pints	watts	min.	kilos	Cwts.
GKKW 300	300	525	30	65	450	9
GKKW 600	600	1050	52	85	600	12

*) For three-phase current 220/380 and 127/220 volts.
**) Heating to about 95° Celsius.

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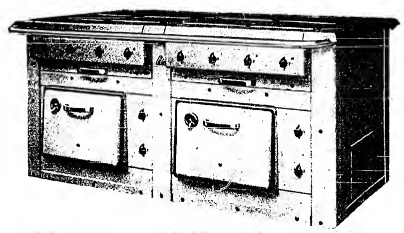

MEDIUM SIZE IKA ECONOMY RANGES

Medium Size Economy Range GKHB . . .

As 4 or 8-burner range with 1 or 2 ovens respectively. The square-shaped burners as well as the top of the range and the bottom elements of the ovens feature 3-stage heat control. Front and side walls are enamelled in white, the range's frame is polished.

With the designation Type GKSHB . . . and in conformity with the respective specifications, these ranges are also delivered for use in ships.

Sizes: 4-burner range . . . height 800 mm, width 900 mm, depth 900 mm
(about 31½ × 35½ × 35½ inches)
8-burner range . . . height 800 mm, width 1800 mm, depth 900 mm
(about 31½ × 71 × 35½ inches)

Accessories: 1 baking-tray and 1 slip-in grill for each oven.

Please state type, voltage and current *).

Type	Burners 300 mm□ 3,0 kW	Ovens				Total Wattage	Weight	
		Number	Each oven: Inside		Wattage			
	Number		mm	appr. inches	approx. kW	approx. watts	approx. kilos	appr. cwts.
GKHB 90/90	4	1	height 260	10 1/4	3	15	250	5
			width 420	16 1/2				
GKHB 163/90	8	2	depth 560	22	3	30	500	10

*) Normal voltage 220 volts, for A. C. and three-phase current. Special voltages or currents on request.

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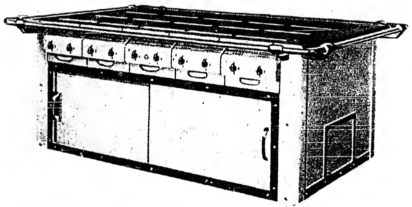


LARGE SIZE IKA ECONOMY RANGES

Heat compartment ranges

Large size Economy range GKHW . . .

Available as 12 or 18-burner range with heat compartment underneath. The square-shaped burners and the heat compartment feature 3-stage heat control. All walls of the range are enamelled in white, the range's frame is polished.

With the designation GKHT . . . these devices are also available as Table Ranges. Instead of the heat compartment, a shelf will be delivered.

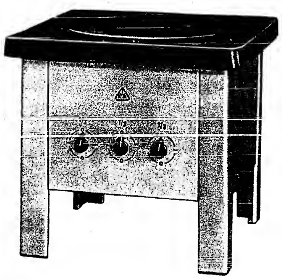
Sizes: 12-burner range . . . height 800 mm, width 1560 mm, depth 1250 mm (about 31½ × 61½ × 49¼ inches)

18-burner range . . . height 800 mm, width 2180 mm, depth 1250 mm (about 31½ × 85¾ × 49¼ inches)

Please state type, voltage and current *).

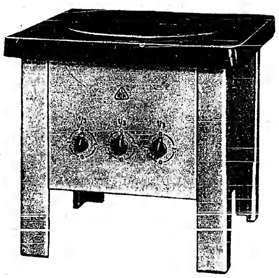
Type	Burners 300 mm □ appr. 11¾ inch. □		Heat Compartment Wattage	Total Wattage	Weight	
	1,6 kW Number	3 kW Number	approx. watts	approx. watts	kilos	approx. cwts.
GKHW 156/125	6	6	4	31,6	850	17
GKHW 218/125	9	9	4	46,4	1300	26

*) Normal voltage 220 volts, for A. C. and three-phase current. Special voltages or currents on request.



IKA ELECTRIC CONSOLE RANGE

hornillos



hornillo eléctrico de planta baja ?

IKA ELECTRIC CONSOLE RANGE

Console Range GKOV 40 Elektrohocker

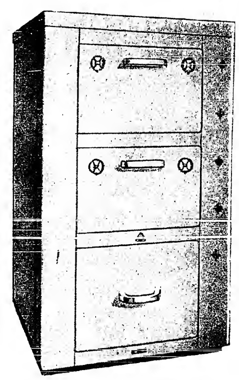
For heating and cooking of larger quantities of food and of beverages. A 3-step switch permits the reduction of the total consumption to 1/4 of the nominal wattage. Case and feet are enamelled in white, the cast-iron cover plate is blackened.

Size: Height 500 mm, width 525 mm, depth 525 mm (abt. 19¾ × 20½ × 20½")

Please state type, voltage and current *).

Type	Diameter of burner		Wattage	Weight	
	mm	approx. inches	approx. kW	approx. kilos	cwt.
GKOV 40	400	15 3/4	6	50	1

*) Normal voltage is 220 volts, for AC and three-phase current. Delivery of other voltages and currents on request.



IKA 3-FLOOR GRILLING AND BAKING OVENS (UNITS)

3-Floor Unit GKEW 250

The unit comprises 2 piled-up grilling and baking ovens and a heating and fermenting compartment underneath. The top and bottom elements of the 2 ovens and the bottom-heated compartment feature 3-step switches. The one-piece casing of new design enamelled in white; recessed doors.

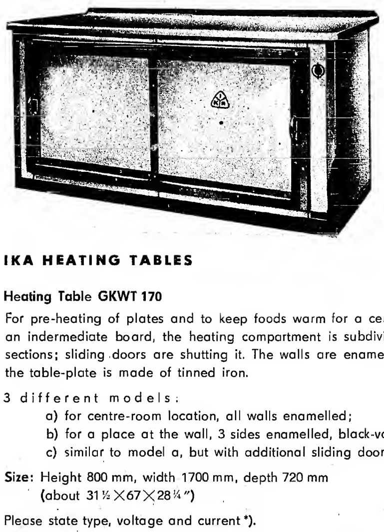
Size: Height 1585 mm, width 930 mm, depth 900 mm (abt. 62½ × 36½ × 35½")

Accessories: 2 baking-trays, 2 slip-in grills.
further 2 frying-pans against extra charge.

Please state type, voltage and current *).

Type	Each oven			Heat compartment			Total wattage	Weight	
	Inside		Wattage	Inside		Wattage		approx.	
	mm	approx. inches	approx. kW	mm	approx. inches	approx. kW	approx. kW	kilos	cwts.
GKEW 250	height 280 width 500 depth 750	11 19 3/4 29 1/2	4,5	height 420 width 500 depth 750	16 1/2 19 3/4 29 1/2	1,1	10,1	375	7.2.0

*) Normal voltage is 220 volts, for AC and three-phase current. Other voltages and currents on request.



IKA HEATING TABLES

Heating Table GKWT 170

For pre-heating of plates and to keep foods warm for a certain time. By an intermediate board, the heating compartment is subdivided into two sections; sliding doors are shutting it. The walls are enamelled in white, the table-plate is made of tinned iron.

3 different models:

a) for centre-room location, all walls enamelled;
b) for a place at the wall, 3 sides enamelled, black-varnished rear.
c) similar to model a, but with additional sliding doors at the rear.

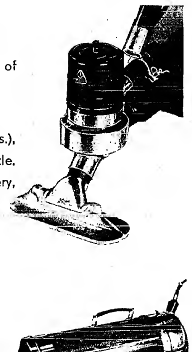
Size: Height 800 mm, width 1700 mm, depth 720 mm
(about 31½ × 67 × 28¼")

Please state type, voltage and current *).

Type	Wattage approx. kW	Weight approx. kilos	approx. cwts.
GKWT 170a	3	225	4.2.0
GKWT 170b	3	225	4.2.0
GKWT 170c	3,5	250	5.0.0

*) Normal voltage is 220 volts, for A. C. and three-phase current. Other voltages and currents on request.

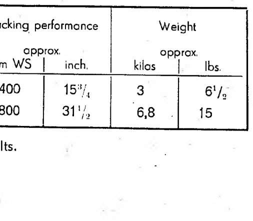
IKA VACUUM CLEANERS



Vacuum Cleaner 1039

The cleaner for versatile application, made of light metal. Universal motor for AC and DC.

Accessories:
Motor-dome with a 4-m cord (about 4½ yds.), handle, dustbag, flexible rug-cleaning nozzle, nozzle for reaching into folds of upholstery, brush nozzle, hot-air fan.



Vacuum Cleaner 1035

The practical, mobile vacuum cleaner for household and office.

Accessories:
Hose, carpet-brush, small and large rug-cleaning nozzles and upholstery-nozzle, 1 straight and 1 bent extension tube, 5-m (abt. 5½ yds.) extension cord.

Please state type and voltage *).

Type	Wattage approx. watts	Sucking performance approx. mm WS	inch.	Weight approx. kilos	lbs.
1039	125	400	15¾	3	6½
1035	260	800	31½	6,8	15

*) Normal voltages 120 and 220 volts.

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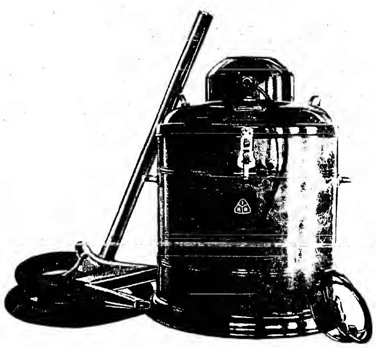

IKA HEAVY DUTY VACUUM CLEANER 7350.1

This cleaner in the shape of a pot is equipped with 2 handles. Ball-bearing twin-casters permit an easy transportation even on rough floors. Specially suited for offices, mills, clubs, hotels, etc.

Accessories: 1 flexible hose, 1 extension tube, nozzles for upholstery and carpets.

Please state type and voltage *).

Type	Wattage approx. watts	Sucking performance approx. mm WS	inch.	Weight approx. kilos	lbs.
7350.1	365	800	31 1/2	16,5	36

*) Normal voltage 120 and 220 volts.

IKA TABLE FANS

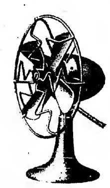

Table Fan, Type 1034
Universal motor for AC/DC, with wire guard.

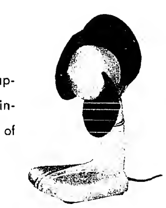

Table Fan, Type 73 50.5
For 120 or 220 volts AC, motorhead adjustable upwards, may also be used as wall fan. Speed infinitely variable. Accident-proof blades, made of soft rubber.

Please state type and voltage *).

Type	Wattage approx. watts	Diameter of blades mm	approx. inch.	Weight approx. kilos	lbs.
1034	20	180	7	1	2 1/4
7350.1	24	255	10	4,4	9 3/4

*) Standard voltage 120 and 220 volts.

IKA HOT AIR FANS

Type 1020

Hair dryers 1020 and 1022

To be used for many purposes, e. g., for hair drying, drying of gloves, stockings, photoplates, etc.

High-gloss finish.

Hot Air Fan 371.1

For versatile application. The plastic made casing offers dependable protection against electric shocks. This fan, in its handy shape, eliminates fatigue in use due to the favourable balancing of the gravity. Precise aiming of the air current, since it is in one direction with the handle.

Please state type and voltage *).

Type	Performance	Wattage approx. watts	Weight approx. kilos	oz.
1020	with cord switch	350	0,65	$23^1/_2$
1022	with embedded switch	400	0,75	27
371.1	minus switch	450	0,65	$23^1/_2$
371.1	with switch "Cold-Hot" in the cord	450	0,7	25

*) Standard voltage 120 and 220 volts.

INHALTSVERZEICHNIS

GLEICHRICHTER (STROMRICHTER) Gruppe 38

Quecksilberdampfgleichrichter . . . . a
Quecksilberdampfgleichrichteranlagen . . . . a 1
Quecksilberdampfgleichrichter . . . . a 2

Trockengleichrichter . . . . b
Selen-Trockengleichrichter . . . . b 1
Kupferoxydulgleichrichter . . . . b 2
Kupferoxydulgleichrichter für Hochfrequenz . . . . b 2/1
Kupferoxydulgleichrichter für Fernmeldezwecke . . . . b 2/2
Kupferoxydulgleichrichter für Meßzwecke . . . . b 2/3

Stromrichter c
Mechanische Stromrichter . . . . c 1
Röhrengleichrichter . . . . c 2

Zerhacker . . . . d

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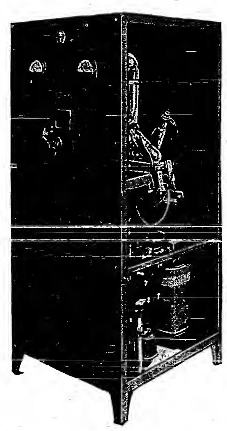
DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



QUECKSILBERDAMPF-GLASGLEICHRICHTER
TYP QBD

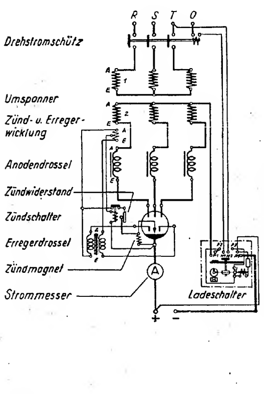
für Elektrofahrzeug-Batterieladung

Als Gleichrichter zum Laden von Elektrokarrenbatterien. Zum Anschluß an Drehstromnetze. Ladestrom 30 bzw. 40 A.

Der Gleichrichter besteht aus:
Umspanner mit getrennten Wicklungen
Glaskörper (Gleichrichterventil)
selbsttätiger Federzündeinrichtung
Anodendrasseln
Drehstromschütz
Strom- und Spannungsmesser
Ladeschalter (Bauart Pöhler)
Drehstrom- und Gleichstrom-Anschlußklemmen

Die Gleichrichter werden mittels des Ladeschalters eingeschaltet. Dieser ist so eingestellt, daß das Uhrwerk bei 2,4 V Zellenspannung, d. h. bei Beginn der Gasung der Batterie anspricht und nach Ablauf der für die Batterie vorgeschriebenen zwischen $^1/_2$ und 6 Stunden einstellbaren Nachladezeit abschaltet.
Der für jede Gleichrichtertype angegebene Ladestrom ist der Anfangsladestrom, welcher mit steigender Spannung langsam abnimmt und bei Einsetzen der Gasung ca. 50 %, am Ende der Ladung ca. 20 % des Anfangsladestromes beträgt.

Typ	Anschluß-spannung 50 Hz V	Gleichstrom-leistung Zellen	Gleichstrom-leistung A	Gerät einschl. Glaskörper Gewicht ca. kg	Ersatz-Glaskörper Typ	Ersatz-Glaskörper Gewicht netto ca. kg	Liefer-werk
QBD 80/30	Drehstrom 3×380*) oder 3×220	40	30	120	DK 346 F	1,8	302
QBD 80/40			40	130	DL 37 a F	2,7	



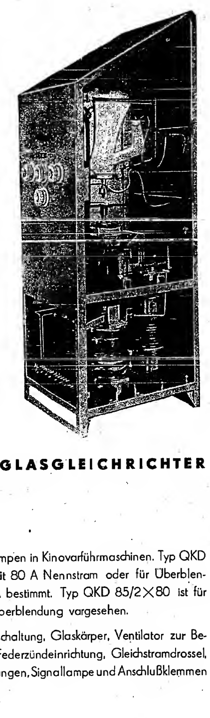
Bei Bestellung angeben:
Typ, Anzahl der Zellen, Anschlußspannung, Batterieart und -größe.

Sonderausführung:
Typ QBD ... / ... mit Regelung durch Regelschalter, Typ QND ... / ... für Netzbetrieb auf Anfrage.

*) Gleichrichter für andere Spannungen, Zellenzahlen und Stromstärken auf Anfrage.

Gleichrichter zur Ladung von Stahlbatterien (alkal. Batterien) auf Anfrage.

Einrichtung für zeitliche Nacheinanderladung von 2 gleichen Batterien (einschl. 2 Ladeschalter und Umschaltschütz) gegen Sonderberechnung.



QUECKSILBERDAMPF-GLASGLEICHRICHTER TYP QKD

für Kinobogenlampen

Die Gleichrichter dienen zum Speisen der Bogenlampen in Kinovorführmaschinen. Typ QKD 85/80 ist für die Speisung einer Bogenlampe mit 80 A Nennstrom oder für Überblendungsbetrieb bei einer Stromstärke von 2×60 A bestimmt. Typ QKD 85/2×80 ist für die Speisung von zwei 80-A-Bogenlampen bei Überblendung vorgesehen.

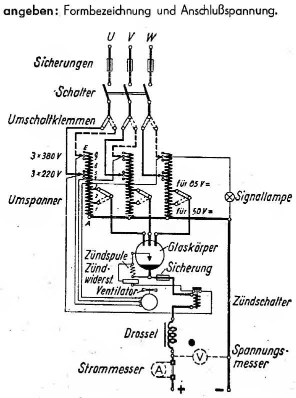
Der Gleichrichter besteht aus: Umformer in Sparschaltung, Glaskörper, Ventilator zur Belüftung des Glaskörpers (bei QKD 85/2×80), Federzündeinrichtung, Gleichstromdrossel, Gleichstromsicherung, Drehstromschalter, Netzsicherungen, Signallampe und Anschlußklemmen für Dreh- und Gleichstromanschluß

Wirkungsweise: Der Gleichrichter ist nach Einschalten des Drehstromschalters sofort betriebsfähig. Für jede Kinobogenlampe muß ein getrennter Vorschaltwiderstand zur Spannungsregulierung angeordnet werden. Dieser Widerstand wird nicht mitgeliefert. Gleichspannung 85 V. Durch Umklemmen kann die Spannung auf 50 V herabgesetzt werden. Für Verwendung von HJ-Kohlen.

Typ	Drehstrom-Anschlußspannung	Gleichstrom-Leistung V	Gleichstrom-Leistung A	Gewicht ca. kg	Lieferwerk
GKD 85/80	3×380 oder 3×220	85/50	80	250	302
GKD 85/2×80	3×380 oder 3×220	85/50	2×80	300	

Gleichrichter für andere Spannungen und Stromstärken auf Anfrage.
Einbau eines Strom- und Spannungsmessers gegen Sonderberechnung.

Bei Bestellung angeben: Formbezeichnung und Anschlußspannung.



Instrumente nur auf besondere Bestellung

TROCKENGLEICHRICHTER

Technische Erläuterungen

Allgemeines

Unter den verschiedenen Ausführungen von Trockengleichrichtern haben sich in der Praxis nur Konstruktionen auf Kupferoxydul- und Selenbasis bewährt. Die in dieser Druckschrift enthaltenen Gleichrichter sind je nach Zweckmäßigkeit mit Kupferoxydul- oder Selensäulen ausgerüstet.

Die Arbeitsweise der Trockengleichrichter beruht auf der unipolaren Wirkung zwischen einem Leiter und einem Halbleiter, d. h. der Strom wird nur in einer Richtung durchgelassen, in der anderen aber – abgesehen von einem geringen Rest – gesperrt. Diese Sperrwirkung wird im Innern der Gleichrichterscheiben bei Kupferoxydul-Gleichrichtern durch die zwischen dem Kupfer und dem Kupferoxydul und bei Selengleichrichtern durch die zwischen dem Selen und der aufgespritzten Gegenelektrode liegenden Sperrschicht erreicht.

Vorteile

Gegenüber umlaufenden Umformern und anderen Gleichrichtern besitzen Trockengleichrichter eine Reihe von Vorteilen. Die wichtigsten sind:

- Hohe Betriebssicherheit
- Keine bewegten und empfindlichen Teile
- Lange Lebensdauer
- Einfacher Aufbau
- Hoher Wirkungsgrad auch bei Teillast
- Sofortiger Einsatz der Gleichrichterwirkung
- Gute Anpassungsfähigkeit an alle konstruktiven und elektrischen Forderungen
- Keine Fundamente
- Keine Ersatzteile
- Geräusch- und rundfunkstörfreier, wartungsloser Betrieb

Anwendungsbereich

Der Anwendungsbereich der Trockengleichrichter ergibt sich aus Bild 1.

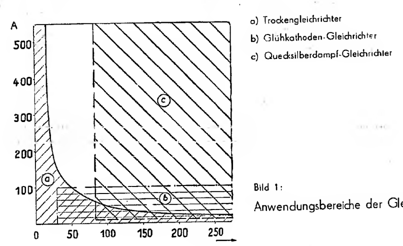


Bild 1:
Anwendungsbereiche der Gleichrichterarten

In dieser Darstellung soll zum Ausdruck kommen, in welchem ungefähren Leistungsbereich die Trockengleichrichter gegenüber anderen Gleichrichtern sowohl hinsichtlich der Anschaffungskosten als auch hinsichtlich des Wirkungsgrades unter normalen Verhältnissen wirtschaftlich sind. Über diese Grenzen hinaus wird oft dort dem Trockengleichrichter der Vorzug gegeben, wo auf große Zuverlässigkeit besonderer Wert gelegt wird. Da die Trockengleichrichter bei allen Spannungen und Strömen ungefähr gleiche Wirkungsgrade besitzen, so übertreffen sie besonders bei kleinen Spannungen bis zu ca. 75 Volt alle anderen Gleichrichterarten.

Die wichtigsten Anwendungsgebiete für Trockengleichrichtergeräte sind folgende:

Ladung von Batterien: für Schnell- und Dauerladung, selbstregelnde Dauerladung und Regel- oder Kippladung, z. B. Batterien für Elektrokarren, Steuerzwecke in Schaltanlagen, Notbeleuchtung, Personen- und Lastkraftwagen, Motorräder, Meß- und Experimentiereinrichtungen, Fernsprech-, Signal- und Uhrenanlagen.

Speisung von Magnetspulen, z. B. bei Aufspannplatten, Magnetkupplungen, Magnetscheidern, Relais- und Schütz-Spulen, Gleichstrommaschinen, Buchungsmaschinen, Brems- und Hubmagneten, Ölschalterbetätigung sowie zur Erregung und Abbremsung von elektrischen Maschinen.

Speisung von elektrochemischen Bädern, z. B. in galvanischen Anstalten, chemischen Fabriken, Stahl- und Walzwerken, Scheideanstalten für edle und unedle Metalle, Wasserzersetzungsanlagen, Schriftgießereien und Klischeeanstalten.

Speisung von elektrischen Lichtbögen, z. B. für Bogenlampen, für Kino- und Projektionsgeräte, medizinische und optische Geräte.

Stromversorgung für Fernmeldeanlagen, z. B. Fernschreiber, Fernsprechnebenstellen, Verstärkerämter und Sender.

Als Gleichrichter für Meß- und Hochfrequenzzwecke und als nicht linearer Widerstand in Trägerfrequenzeinrichtungen, z. B. Meßgleichrichter, Bauelement in der Rundfunkindustrie, Modulator, Demodulator, Amplitudenbegrenzer.

Als Ventil in Gleichstromkreisen, z. B. in verschiedenen Steuerungen der Stark- und Schwachstromtechnik.

Frequenz

Die Gleichrichtergeräte sind für den Anschluß an normale Wechselstromnetze 50 Per/s bemessen. Abweichende Frequenzen sind auf die Wirkungsweise der Trockengleichrichterventile ohne Einfluß, jedoch müssen die magnetischen Kreise, wie z. B. Transformator und Drosselspulen, entsprechend ausgelegt werden.

Gleichspannung und Gleichstrom

Gleichspannung und Gleichstrom sind in den Beschreibungen der einzelnen Geräte als arithmetische Mittelwerte angegeben, also als Werte, die durch Drehspulinstrumente gemessen werden. Die angegebene Gleichspannung gilt bei Abgabe des Nennstromes. Bei Geräten ohne Regeleinrichtung steigt bei Entlastung die Spannung an. Die Leerlaufspannung liegt ca. 20 % bis 40 % höher, je nach Schaltung und Verwendungszweck des Gleichrichters.

Da bei Einphasen-Gleichrichtern die Gleichspannung bei Batterieladung gegenüber der Spannung bei Speisung von Widerständen und Magnetwicklungen stark voneinander abweicht, können die Geräte immer nur für den in der Liste angegebenen Zweck benutzt werden. Bei den Batterieladegeräten ist die Gleichspannung so angegeben, daß sie der Nennspannung der Bleizellen, also 2 Volt je Zelle, entspricht. Die für die richtige Ladung notwendigen höheren Spannungswerte ergeben sich dabei selbsttätig bei Änderung des Batterieladezustandes unter gleichzeitiger Änderung der abgegebenen Stromstärke.

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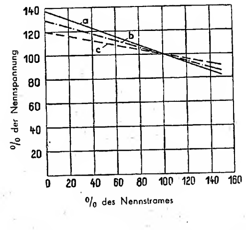
Belastungsart, Betriebsweise

Hinsichtlich der Belastungsart und Betriebsweise werden in dieser Liste unterschieden:

bei Batterieladung	bei Widerstandsbelostung
a) Schnelladung (10 Stunden täglich)	10stündiger Tagesbetrieb
b) Dauerladung	24stündiger Tagesbetrieb
c) Selbstregelnde Dauerladung	Bemessung für kleinen
d) Regelladung	Spannungsabfoll

Die Gleichrichter für a, b und c unterscheiden sich vaneinander durch einen verschieden großen inneren Sponnungsobfall. Dieser beträgt bei den angegebenen Strömen für die Gleichrichter unter a) etwa 20 % bis 40 %, für die Gleichrichter unter b) etwa 20 % bis 35 % und für die Gleichrichter unter c) etwa 20 % bis 25 %. Der Verlauf der Strom- und Spannungskennlinien für die 3 Gruppen a, b und c geht aus Bild 2 hervor, wobei der Spannungsobfall eines reichlich bemessenen Transformatars schon eingeschlassen ist.



a) Schnelladung
b) Dauerladung
c) Selbstregelnde Dauerladung

Bild 2:
Strom- und Spannungskennlinien

Ein Nachregeln der Ladespannung van Hond erfolgt bei Ladung durch Trockengleichrichter gewähnlich nicht. Durch den Spannungsabfall zwischen Leerlauf und Vollast innerhalb des Gleichrichters und des Gleichrichtertransfarmotars erreicht man, daß mit zunehmender Zellenspannung ein für die Batterie günstiger Stromrückgang ouftritt.

Die in den Tabellen genannten Spannungswerte beziehen sich auf 2 Valt je Zelle bei Blei-Akkumulatoren. Spannungserhähungen, entsprechend 2,7 Valt je Zelle, sind nach zulässig,

wenn der Strom gleichzeitig bis auf etwa 30 % des Nennwertes der Säule zurückgeht und der Gleichrichter nach der Aufladung sowahl wechsel- als auch gleichstromseitig abgeschaltet wird. Soll der Ladestram bei 2,7 Volt je Zelle noch einen größeren Wert besitzen ader wird die Ladespannung mit anderen Mitteln, z. B. veränderlichem Ladewiderstand, nachgeregelt, sa sind die Gleichrichter entsprechend reichlicher auszuwählen.

Batterieladung

a) Schnelladung

Bei der Schnelladung wird die Batterie in verhältnismäßig kurzer Zeit, in der Regel in etwa 10 Stunden oder weniger, aufgeladen. Noch beendeter Ladung wird der Gleichrichter abgeschaltet. Bei Bleizellen erfolgt die Ladung von 2 bis 2,1 Volt, der niedrigsten Zellenspannung bei entladener Batterie, bis auf etwa 2,6 bis 2,75 Volt. Die Hähe der erreichten Endspannung ist kein absalutes Maß für den erreichten Ladezustand der Batterie. Die Höhe der Endspannung hängt vielmehr van verschiedenen Faktaren ab, vor allem van der Hähe des Ladestromes; ein einwandfreies Bild über den Ladezustand gibt nur die Säuredichte.

b) Dauerladung oder Pufferung

Bei der Dauerladung oder Pufferung arbeiten Gleichrichter und Batterie douernd parallel. Der Trackengleichrichter hat hierbei die Aufgabe, direkt den Verbrauchsstrom zu liefern, während die Batterie nur bei gräßeren Stramspitzen und beim Ausbleiben der Wechselspannung zur Stromabgabe herangezagen wird. In Zeiten geringeren Strambedarfes wird die Batterie vam Gleichrichter wieder nachgeladen. Der Gleichrichter muß also in der Lage sein, den mittleren Stramverbrauch zu decken, und zwar bei einer Spannung, die mindestens 2,15 Valt je Zelle entspricht. Unter Berücksichtigung des Batterie-Wirkungsgrades und einer genügenden Sicherheit ist es notwendig, den Gleichrichter für einen Strom, bezogen auf 2 Valt je Zelle, zu bemessen, der etwa 60 % höher ist, als dem mittleren Strombedarf entspricht. Je nach dem augenblicklichen Ladezustand, Strombedorf und der Gräße der Batterie im Verhältnis zum Nennstram des Gleichrichters schwankt die Spannung zwischen 2 Valt je Zelle (Entladespannung) und 2,5 bis 2,7 Valt je Zelle. Da der Ladestram des Gleichrichters mit zunehmender Ladespannung abnimmt, wird eine Spannung von 2,5 bis 2,7 Volt je Zelle sich nur einstellen, wenn bei geladener Batterie nur ein geringer ader gar kein Stramverbrauch varhanden ist. Um zu vermeiden, daß der Akkumulator längere Zeit mit der Gasungsspannung von 2,5 Valt oder höher betrieben wird, ist der Ladestrom des Gleichrichters durch die Anzapfungen des Transformators ader durch einen regelbaren Wider-

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stand zweckmäßig dem Verbrauch anzupassen. Ist der Stromverbrauch sehr unregelmäßig und ist über größere Zeiten nur ein kleiner oder kein Stromverbrauch vorhanden, so ist es naturgemäß auch auf diesem Wege nicht möglich, ein stärkeres Gasen der Batterie zu vermeiden. Für solche Fälle ist die Dauerladung oder Pufferung nicht geeignet, sondern die selbstregelnde Dauerladung zu wählen.

c) Selbstregelnde Dauerladung

Die selbstregelnde Dauerladung unterscheidet sich von der Dauerladung nach b) dadurch, daß an der Batterie nur Schwankungen der Spannung von 2 bis etwa 2,4 Volt je Zelle auftreten, und zwar auch bei großen und unregelmäßigen Schwankungen im Stromverbrauch (siehe Bild 3). Da die Zellenspannung auch bei langem Leerlaufbetrieb keine höheren Werte annimmt, ist diese Lademethode auch für solche Batterien geeignet, die, wie z. B. Notbeleuchtungsbatterien, nur selten beansprucht werden, aber in vollgeladenem Zustand zur Verfügung stehen sollen.

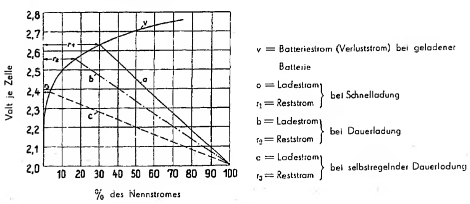
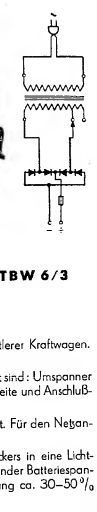


Bild 3:

Ladekennlinien für Schnelladung, Dauerladung und selbstregelnde Dauerladung

Die für die selbstregelnde Dauerladung notwendige Strom-Spannungs-Kennlinie wird durch die Bemessung der Gleichrichter auf geringen Widerstand erreicht. Je nach dem Ladezustand der Batterie und dem Stromverbrauch schwankt der vom Gleichrichter abgegebene Strom zwischen dem Nennstrom und einem kleinen Reststrom, der zur Aufrechterhaltung des Ladezustandes der Batterie bei 2,4 Volt je Zelle notwendig ist. Damit der Gleichrichter in der Lage ist, die Batterie auf vollen Ladezustand zu bringen und auf dieser Höhe zu halten, ist der Nennstrom des Gleichrichters, ebenso wie bei der Dauerladung, etwa 60 % höher zu wählen, als dem mittleren Stromverbrauch entspricht.



LADE-TROCKENGLEICHRICHTER TYP TBW 6/3

Kleinladegerät

Zum Laden von Licht- und Starterbatterien (3 Bleizellen) kleiner und mittlerer Kraftwagen. Ladestrom 3 A, Anschluß-Wechselspannung 220 V 50 Hz.

Der Gleichrichter besteht aus einer Blechgrundplatte, auf welcher aufgebaut sind: Umspanner mit getrennten Wicklungen, Selenelement, Sicherung auf der Gleichstromseite und Anschlußklemmen für die Batteriezuleitung.

Sämtliche Teile sind mit einer grau lackierten Stahlblechhaube abgedeckt. Für den Netzanschluß besitzt der Gleichrichter Anschlußschnur und Stecker.

Die Inbetriebsetzung des Gleichrichters erfolgt durch Einstecken des Steckers in eine Lichtsteckdose. Der Ladestrom beträgt zu Beginn der Ladung 3 A. Bei steigender Batteriespannung fällt der Ladestrom allmählich ab und beträgt am Ende der Ladung ca. 30–50 % des Anfangswertes.

Typ	Bestell-Nr.	Wechselstrom-Anschlußspannung 50 Per/s	Gleichstromleistung		Gewicht netto
		V	V	A	ca. kg
TBW 6/3	145530	220*)	6 (3 Bleizellen)	3	2,5

*) Für andere Anschlußspannung gegen Sonderberechnung.

Lieferwerk: 302

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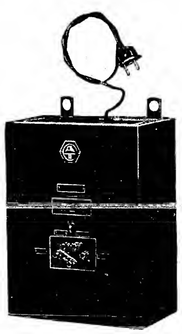
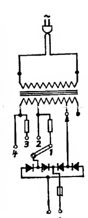




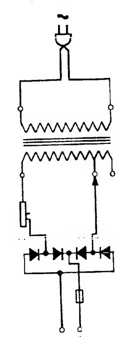
UMSCHALTBARE LADE-TROCKENGLEICHRICHTER TYP TBW .../...u

Zum Laden von Licht- und Starterbatterien, umschaltbar für 3 und 6 Zellen. Anschluß-Wechselspannung 220 V 50 Hz.
Die Gleichrichter werden in 2 Größen hergestellt. Sie enthalten Umspanner mit getrennten Wicklungen, Selenelement, vierstufigen Umschalter, Gleichstromsicherung und Anschlußklemmen für die Batteriezuleitung.
Die Inbetriebsetzung der Gleichrichter erfolgt durch Einstecken des Steckers in eine Lichtsteckdose. Sie sind umschaltbar zur Ladung von 3 oder 6 Zellen. Typ TBW 12/8 u hat die Ladeströme 4 und 8 A. Typ TBW 12/12 u die Ladeströme 6 und 12 A. Die angegebenen Stromwerte treten bei Beginn der Ladung auf. Mit steigender Batteriespannung fällt der Ladestrom langsam ab. Er beträgt am Ende der Ladung ca. 30–50 % des Anfangswertes.

Typ	Bestell-Nr.	Wechselstrom-Anschlußspannung 50 Per/s V	Gleichstromleistung Zellenzahl (Bleizellen)	Gleichstromleistung A	Gewicht netto ca. kg
TBW 12/8 u	145 543	220 *)	umschaltbar auf 3 und 6	umschaltbar 4 auf 8	11
TBW 12/12 u	145 544			umschaltbar 6 auf 12	14

*) Für andere Anschlußspannungen gegen Sonderberechnung.

Lieferwerk: 302



REGELBARE LADE-TROCKENGLEICHRICHTER TYP TBW .../...r

Zum Laden von Batterien verschiedener Verwendungszwecke. Anschluß-Wechselspannung 220 V 50 Hz.

Die Gleichrichter werden in 9 Größen ausgeführt (siehe Tabelle). Sie bestehen aus Umspanner mit getrennten Wicklungen, Selenelement, Regelwiderstand und Gleichstromsicherung.

Wirkungsweise:

Nach dem Einschalten sind die Gleichrichter betriebsbereit. Die angegebenen Stromstärken treten bei Beginn der Ladung auf. Mit steigender Batteriespannung fällt die Ladestromstärke langsam ab. Sie beträgt am Ende der Ladung ca. 30–50 % des Anfangswertes. Mit dem Regelwiderstand ist der Ladestrom zwischen 50 und 100 % des Nennwertes veränderlich. Bei Verwendung für Dauerladung dürfen die Gleichrichter nur mit 80 % des Nennstromes belastet werden. Als Sonderausführung können die Geräte auch umschaltbar für Dauer- und Schnell-Ladung geliefert werden. In dieser Ausführung läßt sich mittels eines zusätzlichen Widerstandes der Dauerladestrom auf ca. 20 % des höchsten Schnell-Ladestromes einstellen.

Gleichrichter zum Laden von Fernsprech- und Stahlbatterien auf Anfrage.

Typ TBW ... r							
für 3, 6 oder 24 Bleizellen entspr. 6, 12 oder 48 V Nenn-Gleichspannung							
Typ	Bestell-Nr.	Wechselstrom-Anschluß-spannung 50 Hz V	Gleichstrom-Leistung		Gewicht netto	Liefer-werk
			Zellenzahl (Bleizellen)	A	ca. kg	
TBW 6/2,4 r	145 571 a	220*)	3	2,4	2,5	302
TBW 6/4 r	145 573 a			4,8	3,5	
TBW 12/4 r	145 598		6	4	4,5	
TBW 12/8 r	145 599			8	8,5	
TBW 48/4 r	145 635		24	4	11	
TBW 48/8 r	145 636			8	30	

*) Für andere Anschlußspannung

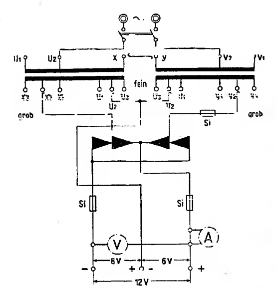
Gegen Sonderberechnung: Für Umschaltung von Stark- auf Dauerladung auf Anfrage.

Bei Bestellung angeben: Typ, Anschlußspannung, Anzahl der zu ladenden Zellen und Ladestrom.

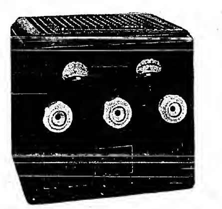
IKA-LADE-TROCKENGLEICHRICHTER TYP LGe 2×6/8s

Anfangsladespannungen: 6 und 12 Volt

Wechselstrom-Anschlußspannung: 235, 220, 125, 110 Volt; 50 Per/s



Netz-Spannung :	110 V	125 V	220 V	235 V
Verbinde :	U_2 y; V_2 X	U_2 y; V_2 X	X y	X y
Netz an :	U_2 V_2	U_1 V_1	U_2 V_2	U_1 V_1



Verwendung: Das Gerät dient zum Laden eines 3- bzw. 6 zelligen oder zweier 3 zelliger Bleiakkumulatoren mit einem Anfangsladestrom von 8 Ampere. Es ist für Dauerbetrieb ausgelegt.

Aufbau: Der Transformator mit getrennten Wicklungen, der Selensäulensatz in Brückenschaltung, die Sicherungen für den Sekundär- und die Gleichstromkreise, die Anschlußklemmen und ein zweipoliger Kippschalter, mit dem der Transformator vom Netz abgeschaltet wird, sind in einem formschönen stabilen, lackierten Stahlblechgehäuse eingebaut. Zwecks guter Durchlüftung ist das Gehäuse teilweise perforiert. Das Gerät ist für Wandaufhängung bestimmt. Es eignet sich jedoch auch als Tischgerät.

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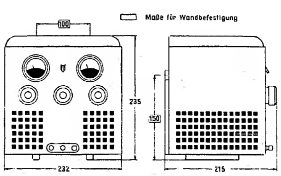
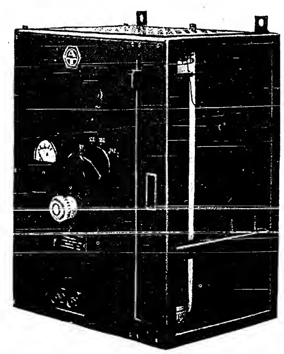
Wirkungsweise: Das Gerät ist der auf Seite 38-b 2.14 dargestellten Schnelladekennlinie entsprechend ausgelegt. Der Anschluß von 3zelligen Batterien erfolgt an der mittleren und einer der äußeren Klemmen, während 6zellige Batterien an den beiden äußeren Klemmen anzuschließen sind. Durch Einschalten des Kippschalters setzt der Ladevorgang nach Anschluß der Batterie ein.

Typ*)	Anfangs-ladespannung	Anfangsladestrom bei 10-Stunden-Betrieb	Anfangsladestrom bei Dauer-betrieb	Gewicht	Liefer-werk
	Volt	Ampere max.	Ampere max.	ca. kg	
LGe 2×6/8 s	6, 12	8	8	6,5	215

*) Das Gerät ist je nach Wunsch ohne oder mit eingebauten Meßinstrumenten mit Drehspulmeßwerk lieferbar.





UMSCHALT- UND REGELBARE LADE-TROCKENGLEICHRICHTER TYP TBW 48/10 ur

Zum Laden von Licht- und Starterbatterien bis 24 Zellen. Ladestrom bis 10 A. Anschluß-Wechselspannung 220 V 50 Hz.

Der Gleichrichter besteht aus Umspanner, Selenelement, vierstufigem Umschalter, Netzschalter, Regelwiderstand, Drehspul-Strommesser und Gleichstromsicherung.

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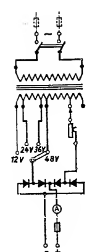


Wirkungsweise:

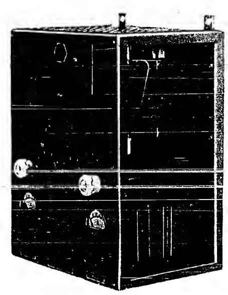
Der Gleichrichter wird mit dem Netzschalter eingeschaltet, nachdem der Umschalter entsprechend der Anzahl der zu ladenden Zellen eingestellt worden ist. Die einstellbaren vier Grundstufen sind in der Tabelle angegeben. Zwischenwerte werden mittels des Regelwiderstandes eingestellt. Bei steigender Batteriespannung fällt der Ladestrom ab. Er beträgt am Ende der Ladung ca. 30–50 % des eingestellten Anfangswertes.

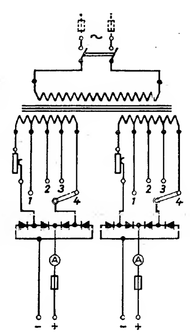
Bei Bestellung angeben: Typ, Anschlußspannung, Ladestrom.

Typ	Bestell-Nr.	Wechselstrom-Anschlußspannung 50 Per/s V	Gleichstromleistung Zellenzahl (Bleizellen)	A	Gewicht netto ca. kg
TBW 48/10 ur	145 551	220*)	umschaltbar 1– 6, 7–12 13–18, 19–24	10	26

*) Gegen Sonderberechnung für andere Anschlußspannung.

Lieferwerk: 302





UMSCHALT- UND REGELBARE LADE-TROCKENGLEICHRICHTER TYP TBW.../...ur

für 2 Ladestromkreise

Zum Laden von Licht- und Starterbatterien von 1–12 bzw. 1–24 Zellen. Anschluß-Wechselspannung 220 V 50 Hz.

Die Gleichrichter werden in 4 Größen hergestellt. Sie enthalten: 1 Umspanner mit getrennten Wicklungen, 2 Selenelemente, 2 Regelwiderstände, 1 Netzschalter, 2 Sicherungen auf der Gleichstromseite, 2 vierstufige Umschalter, 2 Steckvorrichtungen zum Anschließen von Strommessern. Bei dem Typ TBW 2×24/8 ur sind 2 Strommesser eingebaut.

Wirkungsweise:

Die Gleichrichter haben zwei getrennte Ladekreise. Jeder Ladekreis ist umschaltbar für vier Gleichspannungen. Mittels Regelwiderstand ist der Ladestrom zwischen 50 und 100 % veränderlich. Beide Ladekreise können parallel oder in Reihe geschaltet werden. Die in der Tabelle angegebenen Stromwerte treten bei Beginn der Ladung auf, mit steigender Batteriespannung fällt die Ladestromstärke. Sie beträgt am Ende der Ladung 30–50 % des Anfangswertes.

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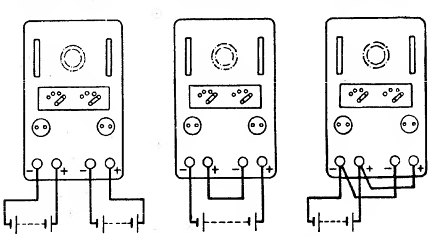
TYP TBW 2×12 ... ur UND TYP TBW 2×24 ... ur								
Vielfach umschaltbar von 2 ... 24 Bleizellen, wie nachfolgend angegeben, Ladestromstärke je Ladekreis 4 bzw. 8 A herabregelbar auf 50 %								
Typ	Bestell-Nr.	Wechselstrom-Anschluß-Spannung 50 Per/s V	Gleichstrom-Leistung Zellenzahl (Bleizellen) je Ladekreis	2 Kreise in Reihe	2 Kreise parallel	A	Gewicht netto ca. kg	Lieferwerk
TBW 2×12/4 ur	145707	220 *)	1 ... 6 —	2 ... 12 —	— 1 ... 6	4 8	14	302
TBW 2×12/8 ur	145708		1 ... 6 —	2 ... 12 —	— 1 ... 6	8 16	17	
TBW 2×24/4 ur	145709		1 ... 12 —	2 ... 24 —	— 1 ... 12	4 8	18	
TBW 2×24/8 ur	145710		1 ... 12 —	2 ... 24 —	— 1 ... 12	8 16	40	

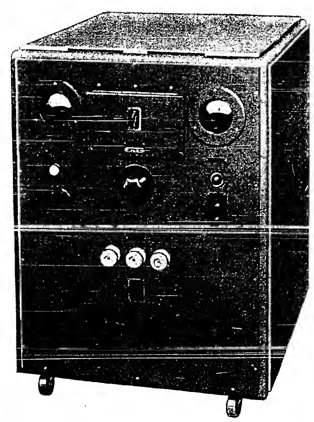
*) Gegen Sonderberechnung für andere Anschlußspannung

Schaltung der Ladekreise

Beide Ladekreise getrennt — Beide Ladekreise in Reihe — Beide Ladekreise parallel



	Beide Ladekreise getrennt		Beide Ladekreise in Reihe	Beide Ladekreise parallel
	1 ... 6 Zellen	1 ... 6 Zellen	2 ... 12 Zellen	1 ... 6 Zellen
	1 ... 12 Zellen	1 ... 12 Zellen	2 ... 24 Zellen	1 ... 12 Zellen
bei TBW 2× .../4 ur	4 A	4 A	4 A	4 A
bei TBW 2× .../8 ur	8 A	8 A	8 A	16 A



REGEL-GLEICHRICHTER

Beliebig einstellbare Gleichspannung

Spannungsquelle und Regelorgan eine handliche Einheit

Zweck: In der Elektrotechnik werden sehr häufig veränderliche Gleichspannungen benötigt. Benutzt werden hierzu meist feste Spannungsquellen mit nachgeschalteten Widerständen oder Spannungsteilern. Der Nachteil solcher Anordnungen, insbesondere wenn größere Spannungen oder Leistungen geregelt werden müssen, liegt darin, daß einmal ein hoher Leistungsverlust eintritt und zum anderen die Widerstände und Spannungsteiler u. U. sehr groß und kostspielig werden.

Mit unseren Regelgleichrichtern wurde nun ein Gerät geschaffen, das Gleichspannungsquelle und Regelorgan zu einer handlichen kleinen Einheit vereinigt.

Die Ausgangsspannung kann von Hand beliebig eingestellt werden. Das Gerät wird aus dem Wechselstromnetz gespeist und entnimmt nur die wirkliche Nutzleistung. Der innere Widerstand und damit die Lastabhängigkeit sind gering.

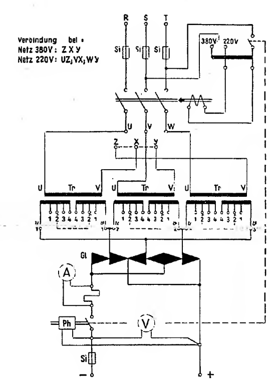
Arbeitsweise: Mittels eines Ringkern-Regeltransformators wird den Gleichrichtern eine fast stufenlos regelbare Wechselspannung zugeführt und gleichgerichtet. Da die Regelung rein induktiv erfolgt, ist der innere Widerstand der Anordnung klein.

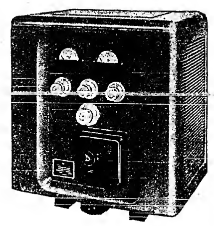
Ausführung: Es werden z. Z. Geräte für Ein- bzw. Dreiphasenanschluß bis zu 6 kW Gleichstromleistung gebaut.
Die Brummspannung beträgt je nach Type ca. 1% bzw. 5%.
Unsere nachstehend aufgeführten Standard-Typen besitzen alle Strom- und Spannungsmesser (siehe auch die umstehende Abbildung).
Die 3-kW- und 6-kW-Typen sind mit Druckknopfsteuerung ausgerüstet.

Typenreihe:

0,4 kW	**1 kW**
40 V/10 A	400/2,4 A
300 V 1,2 A	800 V/1,2 A
bis 10 kV als Sonderfertigung	
Einphasen-Netzanschluß	Einphasen-Netzanschluß
220 V	220 V
Brummspannung ca. 5%	Brummspannung ca. 5%
3 kW	**6 kW**
1 kV/3 A und	3 kV/2 A und
2 kV 1,5 A umschaltbar	6 kV/1 A umschaltbar
Dreiphasen-Netzanschluß	Dreiphasen-Netzanschluß
380 V	380 V
Brummspannung ca. 1%	Brummspannung ca. 1%

Lieferwerk: 444





IKA-LADE-TROCKENGLEICHRICHTER
ELEKTROKARREN-LADEGERÄT TYP LGd 80/30 sm

Anfangsladespannung: 84 Volt

Drehstrom-Anschlußspannung: 380/220 Volt; 50 Per/s

Verwendung:

Das Gerät dient zum Laden von 40zelligen Bleibatterien in Elektrofahrzeugen.

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Aufbau:

In einem besonders zweckmäßigen, stabilen, lackierten Stahlblechgehäuse sind eingebaut: der Transformator mit getrennten Wicklungen, der Selensäulensatz in Drehstrom-Brückenschaltung, ein Ladeschalter System „Pähler" zur selbsttätigen Abschaltung mit $^1/_2$- bis 6 stündiger Uhrlaufzeit für die Nachladung. Ferner drei Anschlußklemmen, ein dreipoliges Schütz, drei Sicherungen auf der Primärseite, eine Sicherung auf der Gleichstromseite, Strom- und Spannungsmesser und eine Ladesteckdose mit Stecker. Das Gerät ist für Wandaufhängung oder für Sockelaufstellung eingerichtet, wobei eine ausreichende Belüftung von unten und auch von beiden Seiten gewährleistet sein muß.

Wirkungsweise:

Die Ladung der Batterie setzt nach Anschluß derselben an die Ladesteckdose und darauf folgendes Einschalten des Pähler-Schalters ein. Nach beendeter Aufladung erfolgt selbsttätige Abschaltung der Batterie und des Gleichrichter-Gerätes.

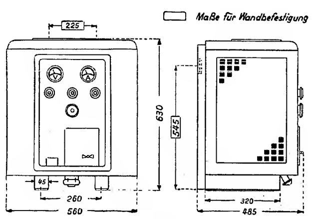

Abb. 7

Typ	Anfangs-ladespannung Volt	Anfangs-ladestrom Ampere max.	Gewicht ca. kg
LGd 80/30 sm	84	30	105

Lieferwerk: 215

KONSTANT-GLEICHRICHTER

Beliebig einstellbare Gleichspannung

Trotz Netz- und Lastschwankungen hochkonstant

Zweck: Auf dem ganzen Gebiet der elektrischen Meßtechnik und bei der Fabrikation elektrischer Geräte macht sich immer wieder das Fehlen konstanter Gleichspannungsquellen unangenehm bemerkbar. Die bisher meist verwendeten Batterien oder Akkumulatoren sind in der Anschaffung teuer, bedürfen einer regelmäßigen Wartung und erfüllen die Anforderungen hinsichtlich Spannungs- und Belastungskonstanz nur sehr unvollkommen.

Diesem empfindlichen Mangel wird nun durch unseren Konstant-Gleichrichter abgeholfen. Derselbe wird aus dem Wechselstromnetz betrieben und liefert eine innerhalb bestimmter Grenzen, die von der Type abhängig sind, beliebig von Hand einstellbare Gleichspannung. Die einmal eingestellte Ausgangsspannung ist hochkonstant, wobei sowohl Netzschwankungen als auch Lastschwankungen automatisch ausgeregelt werden. Da der Regelvorgang durch Elektronenröhre, also trägheitslos erfolgt, wird auch der Netzbrumm, der ja ebenfalls eine Gleichspannungsänderung darstellt, mit ausgeregelt.

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Damit wurde eine kleine und handliche Gleichspannungsquelle geschaffen, die sich bereits in vielen Instituten, Laboratorien, Prüffeldern, Eichplätzen und in der Fabrikation gut bewährt hat. Gerade auf den modernsten Gebieten der Hochfrequenz- und Elektronen-Technik (z. B. für Meßverstärker, UKW., Braun'sche Röhren, Fernsehen, Zählrohre und elektronische Meßgeräte aller Art) besteht dringender Bedarf nach einem solchen Gerät.

Arbeitsweise: Bei unseren Konstant-Gleichrichtern wird der innere Widerstand einer im Hauptstromkreis liegenden Elektronenröhre automatisch immer so geändert, daß alle Spannungsschwankungen, gleichgültig, ob sie von Netz- oder Lastschwankungen herrühren, nur als Schwankungen des inneren Spannungsabfalles dieser Röhre auftreten. Die eingestellte Ausgangsspannung hingegen bleibt konstant.

Gesteuert wird der Regelvorgang durch eine zweite Röhre, die sowohl in Vorwärts- als auch in Rückwärtsregelung arbeitet, d. h. einmal wirken auf ihr Steuergitter die vor der Regelröhre herrschenden Spannungsschwankungen, während zum anderen die nach verbleibenden kleinen Spannungsschwankungen der geregelten Spannung zurückgeführt und abermals zur Regelung herangezogen werden. Dadurch wird eine fast vollständig konstante Ausgangsspannung erzielt.

Technische Werte aller Typen:

Betriebsspannung 220 V / 50 Hz

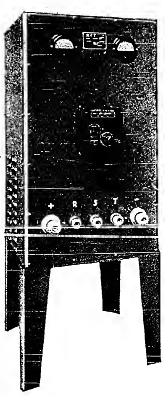
Kanstanz der Gleichspannung: a) bei +10 und −15 % Netzschwankungen 0,5 %
b) bei Lastschwankungen zwischen 0 und Vollast 1 %

Brummspannung ca. 0,1 %

Typen:	KG 400/0,2 a	KG 400/0,2 b	KG 3000/0,2 a
Gleichspannung regelbar von bis	200 V 400 V	40 V 400 V	300 V 3000 V
Max. Gleichstrom	180 mA	200 mA	200 mA
Röhrenbestückung	3 × Ec 2 × EYY 13 1 × FF 12 1 × GR 100 z	3 × Ec 2 × EYY 13 1 × EF 12 1 × AZ 11 1 × GR 150 DM	
Abmessungen ca.	210 × 265 × 365	330 × 405 × 400	

Lieferwerk: 444

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



RFT-LADEGLEICHRICHTER FÜR ELEKTRO-FAHRZEUGBATTERIEN

Diese RFT-Ladegeräte sind zum Aufladen der Antriebsbatterien von Elektro-Fahrzeugen bestimmt. Der in den Geräten eingebaute Ladeschalter – System Pähler – überwacht den Ladevorgang selbsttätig und schaltet bei beendeter Ladung die Batterie vom Gleichrichter und das Gerät vom Netz ab. Durch die Automatisierung der Ladung kann diese unbeaufsichtigt bleiben und während der Nachtzeit geschehen. Die Regelung der Ladung geschieht selbsttätig durch eine eingebaute Regeldrossel. An eingebauten Meßgeräten können die Batteriespannung und der Ladestrom kontrolliert werden.

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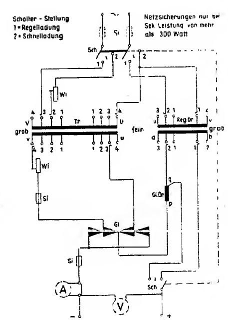
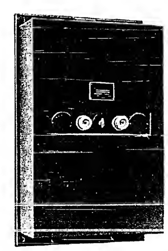
Typ	Anschluß Drehstrom V	Primär-leistung kW	Frequenz Hz	Anzahl der Bleizellen	Maximaler Anfangs-ladestrom A
FB 20/30	380/220	1,7	50	20	30
FB 24/40	380/220	2,9	50	24	40
FB 30/50	380/220	4,3	50	30	50
FB 40/30	380/220	3,8	50	40	30
FB 40/48	380/220	5,2	50	40	48
FB 90/50	380/220	13	50	90	50

Typ	Batterie-kapazität Ah	Abmessungen Höhe mm	Breite mm	Tiefe mm	Gehäuse	Gewicht kg
FB 20/30	160	832	690	430	V/1	ca. 100
FB 24/40	200	1043	530	530	VI/1	130
FB 30/50	250	1043	530	530	VI/1	152
FB 40/30	160	1043	530	530	VI/1	148
FB 40/48	ca. 250	1165	740	630	VI/3	173
FB 90/50	250	1300	1060	630	VI/5	370

Lieferwerk: 112





FGe 24/4-3 srd
FGe 24/8-5 srd

IKA-FERNMELDE-TROCKENGLEICHRICHTER

Typ FGe 24/4-3 srd
FGe 24/8-5 srd
FGe 24/12-8 srd
FGe 24/20-15 srd

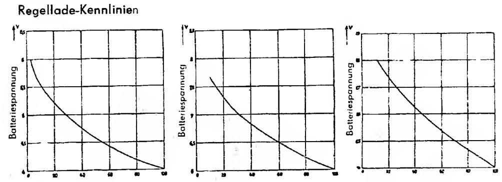
Batterie-Nennspannung 24 Volt

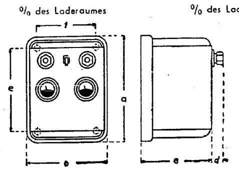
Wechselstrom-Anschlußspannung: 220 Volt, 50 Per/s

Typ*)	Batteriespannung Volt	Ladestromstärke Ampere	Tägl. Strombedarf der Anlage Ah	Größe der Batterie (Pufferbetrieb) Ah	Nennstromstärke der außerhalb d. Gerätes vorzusehenden Netz-Sicherung Ampere	Nennstromstärke der im Gerät eingebauten Sekundär-Sicherung Ampere	Gewicht ca. kg	Lieferwerk
FGe 4/0,3r	4	0,3	3	5	2	1	4	215
FGe 4/1,2r	4	1,2	14	25	2	2	4,3	
FGe 6/0,7r	6	0,7	8	15	2	1	4,5	
FGe 6/4r	6	4,0	50	66	2	10	9,8	
FGe 24/0,7r	24	0,7	8	15	2	2	9,8	
FGe 24/1,5r	24	1,5	18	32	2	4	11	

*) Sämtliche Typen sind je nach Wunsch ohne oder mit eingebauten Meßinstrumenten mit Drehspulmeßwerk lieferbar.

Regellade-Kennlinien





Typ	a	b	c	d	e	f
FGe 4/0,3r FGe 4/1,2r FGe 6/0,7r FGe 6/4r	228	178	160	25	101	132
FGe 24/0,7r FGe 24/1,5r	338	248	185	25	296	206

Lieferwerk: 215

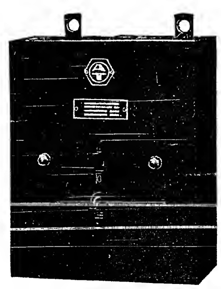


Abb. 1

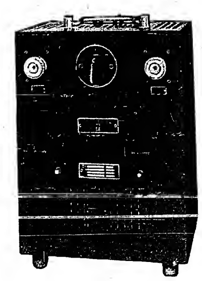


Abb. 2. Typ TNW 160/2

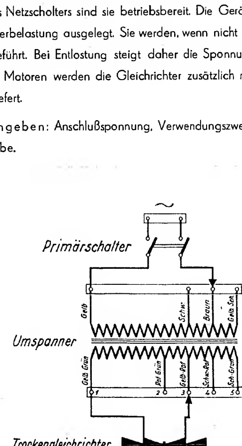
TROCKENGLEICHRICHTER FÜR MAGNETE UND MOTOREN TYP TNW ... bzw. TND ...

Die Gleichrichter sind zum Speisen von Motoren, magnetischen Spannplatten und anderen Gleichstromgeräten bestimmt.

Aufbau: Die Gleichrichter werden je für den gewünschten Nennstrom hergestellt. Bis zu einer Leistungsabgabe von zirka 1000 Watt werden die Geräte zum Anschluß an Wechselstrom, bei größeren Leistungen zum Anschluß an Drehstrom ausgelegt. In Normalausführung sind vorgesehen: Umspanner, Selenelemente in Graetzschaltung, Netzschalter und Gleichstromsicherung. Sämtliche Teile werden auf eine Stahlblechplatte aufgebaut und mit einer Stahlblechhaube abgedeckt. Größere Geräte werden als Standgeräte gebaut. Spezialausführungen, z. B. für Buchungsmaschinen (siehe Abb. 2) werden gleichfalls gefertigt.

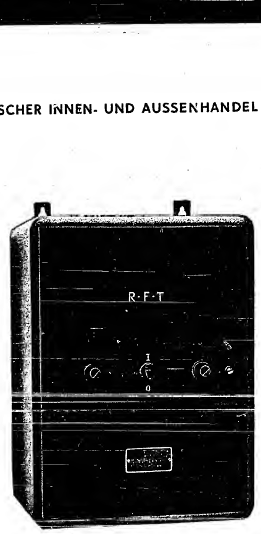
Wirkungsweise: Die Gleichrichter können direkt an das Netz angeschlossen werden. Durch Einschalten des Netzschalters sind sie betriebsbereit. Die Geräte werden auf Grund der Leistung für Dauerbelastung ausgelegt. Sie werden, wenn nicht besonders gewünscht, nicht regelbar ausgeführt. Bei Entlastung steigt daher die Spannung um ca. 20% an. Für das Speisen von Motoren werden die Gleichrichter zusätzlich mit einer eingebauten Glättungsdrossel geliefert.

Bei Bestellung angeben: Anschlußspannung, Verwendungszweck, sekundäre Strom- und Spannungsabgabe.

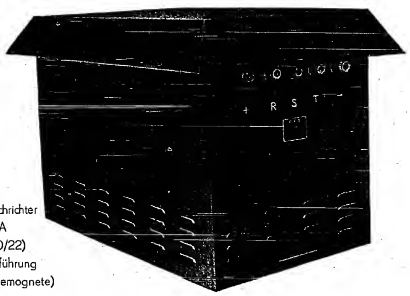


Normalschaltung

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK



Trockengleichrichter
220 V, 1,2 A
(GWE 110/1,2)



Trockengleichrichter
220 V, 22 A
(GWD 220/22)
(Sonderausführung
für Lasthebemagnete)

RFT-TROCKENGLEICHRICHTER

RFT-Trockengleichrichter für verschiedene Verwendungszwecke

Für viele Gebiete der Technik ist die Anwendung von Gleichstrom notwendig. Außer bei der verbreiteten Benutzung zur Batterieladung wird auch für folgende Zwecke unbedingt Gleichstrom benötigt:

- Gleichstrommotoren,
- Magnetspannplatten für Metallbearbeitung,
- Hubmagnete für Lastkrane,
- magnetische Kupplungen,
- magnetische Bremsen,
- Magnetscheideranlagen,
- Schweißanlagen,
- Senderanlagen,
- Prüfanlagen,
- Laboratorien,
- galvanische Bäder,
- Meßeinrichtungen,
- Fernmeldeanlagen.

In all diesen Fällen bewährt sich der Trockengleichrichter wegen seiner großen Vorzüge, von denen die folgenden als die wichtigsten genannt sein mögen:

- Keine beweglichen oder zerbrechlichen Teile;
- keine der Abnutzung unterworfenen Teile;
- einfache Bedienung, geringe Wartung;
- hoher Wirkungsgrad;
- Geräuschlosigkeit;
- geringes Gewicht;
- keine Radiostörungen,
- hohe Lebensdauer.

Der Wirkungsgrad der Trockengleichrichter liegt je nach Größe zwischen etwa 75–85%, der Leistungsfaktor etwa bei 0,8–0,9.

Die Gleichrichter enthalten einen Transformator in Einphasen- oder Dreiphasen-Schaltung mit getrennten Wicklungen, Gleichrichtersatz in Brückenschaltung, Primär- und Sekundärsicherungen, primärseitigen Ein- und Ausschalter, größere Geräte, auch Meßgeräte; je nach Größe, Stahlblechgehäuse mit abnehmbarer Haube oder geschweißter Gestellrahmen mit aufgeschraubter Blechverkleidung. Kleine Geräte werden in schwarzem Kräusellack, größere in graublauem Spritzlack geliefert.

Die einzelnen Daten der Trockengleichrichter sind in den beiden folgenden Tabellen enthalten. Sonderanfertigungen werden jederzeit übernommen.

RFT-Drehstrom-Trockengleichrichter der GWD-Serie

110 V/0,65–6,5 kW; 220 V/1,3–9,8 kW; Netzanschluß 220/380 V 50 Hz

Selen-Trockengleichrichter zur Speisung von Elektromagneten, Gleichstrommotoren usw. Anschluß an Drehstrom 220/380 V, 50 Hz, Transformator mit getrennten Wicklungen, Gleichrichtersatz in Dreiphasen-Graetz-Schaltung, eingebautes Volt- und Amperemeter, primär dreimal und sekundär zweimal abgesichert, primärseitiger 3poliger Ein- und Ausschalter, Ausführung in geschweißter Rahmenkonstruktion mit Blechverkleidung, blaugrau gespritzt.

Typ:								
GWD 110 . . .	110/6	110/12	110/15	110/22	110/30	110/37	110/45	110/60
Gerät . . . Nr.	A3528	A3500	A3501	A3502	A3503	A3504	A3505	A3529
Daten allgemein:								
Gleichspannung V	110	110	110	110	110	110	110	110
Gleichstr.-Leistg. kW	0,65	1,3	1,5	2,3	3,2	3,9	4,8	6,5
Gleichstrom max. A	6	12	15	22	30	37	45	60
Anschlußwert . kVA	0,93	1,84	2,20	3,36	4,6	5,6	6,90	9,17
Primärstrom A 380 V	1,4	2,78	3,36	5,1	7	8,60	10,5	13,9
Primärstrom A 220 V	2,5	4,83	5,80	8,90	12,2	15,0	18,2	2,4
Abmessungen:								
Höhe . . . mm	640	640	905	1043	1043	1165	1165	1165
Breite . . . mm	450	450	530	530	530	740	740	740
Tiefe . . . . mm	290	290	530	530	530	530	630	630
Gewicht . ca. kg	45	75	90	115	140	160	170	220

Typ:							
GWD 220 . . .	220/6	220/12	220/15	220/22	220/30	220/37	220/45
Gerät . . . Nr.	A 3517	A 3507	A 3508	A 3509	A 3510	A 3511	A 3513
Daten allgemein:							
Gleichspannung V	220	220	220	220	220	220	220
Gleichstr.-Leistg. kW	1,3	2,5	3,2	4,7	6,4	8,0	9,8
Gleichstrom max. A	6	12	15	22	30	37	45
Anschlußwert . kVA	1,84	3,67	4,6	6,75	8,55	11,35	13,0
Primärstrom A 380 V	2,8	5,5	6,9	10,2	13	17,2	19,7
Primärstrom A 220 V	4,8	9,6	12,0	17,3	22,5	30	34
Abmessungen:							
Höhe . . . mm	640	905	1043	1165	1165	1345	1345
Breite . . . mm	450	530	530	740	740	740	740
Tiefe . . . . mm	290	530	530	630	630	630	630
Gewicht . ca. kg	70	120	150	170	200	250	270

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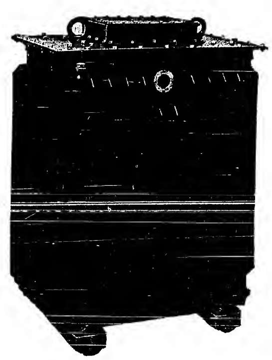
RFT-Einphasen-Trockengleichrichter der GWE-Serie für Magnetspannplatten

110 V/65–850 W; 220 V/130–850 W; Netzanschluß 110/220 V, 50 Hz

Selen-Trockengleichrichter zur Speisung von Elektromagneten, Gleichstrommotoren usw. Anschluß an Wechselstrom 110/220 V, 50 Hz, Transformatoren mit getrennten Wicklungen, Gleichrichtersatz in Einphasen-Graetz-Schaltung, primär und sekundär abgesichert, eingebauter Ein- und Ausschalter, Ausführung in Blechgehäuse für Wandaufhängung. GWE 110/6 und 110/8, sowie GWE 220/2,4 zusätzlich mit Volt- und Amperemeter.

Typ:						
GWE 110	110/0,6	110/1,2	110/2,4	110/4	110/6	110/8
Gerät . . . . Nr.	A 3518	A 3519	A 3520	A 3521	A 3522	A 3523
Daten allgemein:						
Gleichspannung . . V	110	110	110	110	110	110
Gleichstrom-Leistung W	65	130	260	430	650	850
Gleichstrom max. . A	0,6	1,2	2,4	4	6	8
Anschlußwert . . VA	130	245	453	753	1130	1500
Primärstrom A . 220 V	0,06	1,1	2,1	3,5	5,2	6,8
Primärstrom A . . 110 V	0,9	2,2	4,4	7,2	10,8	14
Abmessungen:						
Höhe . . . . . mm	272	332	436	504	640	640
Breite . . . . . mm	252	252	252	252	450	450
Tiefe . . . . . mm	171	171	171	171	290	290
Gewicht . . ca. kg	9	11	18	26,5	40	55

Typ:				
GWE 220	220/0,6	220/1,2	220/2,4	220/4
Gerät . . . . Nr.	A 3524	A 3525	A 3526	A 3527
Daten allgemein:				
Gleichspannung . . V	220	220	220	220
Gleichstrom-Leistung W	130	260	520	850
Gleichstrom max. . A	0,6	1,2	2,4	4
Anschlußwert . . VA	245	453	907	1500
Primärstrom A . 220 V	1,1	2,1	4,1	6,4
Primärstrom A . . 110 V	2,2	4,4	8,8	14
Abmessungen:				
Höhe . . . . . mm	332	436	640	640
Breite . . . . . mm	252	252	450	450
Tiefe . . . . . mm	171	171	290	290
Gewicht . . ca. kg	11	18	43	55,5



RFT-Drehstrom-Trockengleichrichter mit Ölkühlung der GWDO-Serie

Netzanschluß 220/380 V, 50 Hz oder auf Wunsch 500 V

Selen-Trockengleichrichter zur Stromversorgung von Gleichstromverbrauchern aller Art, wie Elektromagnete, Elektromotore usw. Der Gleichrichter ist staub- und wasserdicht in einem Ölgefäß untergebracht und eignet sich besonders zur Verwendung in Gruben, chemischen Betrieben usw. Der Anschluß erfolgt an ein Drehstromnetz 220/380 V oder auf besonderen Wunsch 500 V, 50 Hz. Der Transformator besitzt getrennte Wicklungen. Der Gleichrichtersatz arbeitet in Dreiphasen-Brücken-Schaltung. Voltmeter, Amperemeter, Ein- und Ausschalter und Sicherungen sind im Gerät nicht vorgesehen. Die Lieferung erfolgt normal mit Ölfüllung.

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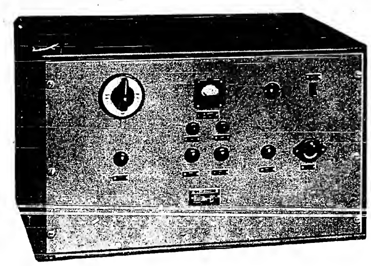
Typ:				
GWDO	220/23	220/36	220/45	220/75
Gerät . . . . Nr.	A 3566	A 3567	A 3568	A 3569
Daten allgemein:				
Gleichspannung . . V	220	220	220	220
Gleichstrom-Leistung kW	5	8	10	17
Gleichstrom max. . A	23	36	45	75
Anschlußwert . . kVA	7	11	14	24
Primärstrom A . 220 V	18,5	29	37	63
Primärstrom A . 380 V	10,6	16,5	21	36
Primärstrom A . 500 V	8	12,5	16	28
Abmessungen:				
Maßbild . . . . Nr.	A 3425	A 3479	A 3426	A 3427
Höhe . . . . . mm	1030	1190	1150	1150
Breite . . . . . mm	695	745	895	1410
Tiefe . . . . . mm	555	605	605	665
Gewicht . . ca. kg				1000

(mit Ölfüllung) auf Anfrage

Lieferwerk: 112



IKA-STROMVERSORGUNGSGERÄT Strg TFc

Das Stromversorgungsgerät Strg TFc dient zur Gleichstromspeisung des Anoden- und Heizkreises eines TFc-Gerätes aus Einphasen-Wechselstromnetzen. Es ist ein Trockengleichrichtergerät und in seiner Konstruktion dem TFc-Gerät angeglichen. Das Stromversorgungsgerät kann weiterhin als Ladegerät für 6zellige Bleibatterien benutzt werden.

Zum Schutz gegen Überlastung ist der Batterieladekreis mit dem Heizkreis so verriegelt, daß gleichzeitige Stromversorgung eines TFc-Gerätes und Batterieladung nicht möglich ist.

Anschluß: Einphasen-Wechselstrom 110, 120, 150, 185, 220, 240 V
Frequenz 50 Hz
Anschlußleistung ca. 115 VA

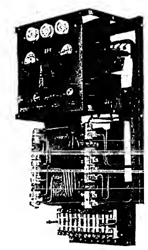
Abgabe: Anode: Gleichspannung 220 V
Gleichstrom 25 mA
Heizung: Gleichspannung 12 V ± 0,5 V
Gleichstrom 0,35 … 1,5 A
Batterieladung: Gleichspannung 12 V
Gleichstrom 3 A

Glättung: Restwelligkeit der Anodenspannung ≦ 0,5 ‰
Restwelligkeit der Heizspannung bei 1,5 A ≦ 1 %

Bauform: Stahlgehäuse Breite 550 mm
Höhe 350 mm
Tiefe (Gehäuse bzw. Größtmaß 310/360 mm)

Gewicht: Einschub allein ca. 26 kg
kompl. mit Gehäuse und Deckel ca. 39 kg

Lieferwerk: 215



RFT-NOTLICHTANLAGEN

für Theater, Lichtspielhäuser, Versammlungsräume usw.

Für elektrische Anlagen in Räumen, die der Allgemeinheit zugänglich sind, insbesondere Lichtspielhäusern, Theatern und großen Geschäftshäusern muß eine Notbeleuchtung vorhanden sein, die bei Ausfall des normalen Beleuchtungsnetzes automatisch auf eine Ersatzstromquelle umgeschaltet wird. Die Ersatzstromquelle kann ein zweites, vom normalen Anschlußnetz völlig unabhängiges Netz sein. Für Großanlagen ist unter Umständen ein besonderer Notstromerzeuger notwendig. Von großem Vorteil ist jedoch die Anwendung einer Akkumulatorenbatterie, da sie den Vorzug der steten Betriebsbereitschaft besitzt. Nur bei ganz kleinen Anlagen (Theater bis zu 200 Plätzen) kann die Notbeleuchtung vom gleichen Netz wie die Hauptbeleuchtung gespeist werden, wenn sie vor den Sicherungen der Hauptbeleuchtung abgezweigt wird und besonders gesichert ist. Von diesem Ausnahmefall abgesehen, wird also in den meisten Fällen eine Akkumulatorenbatterie eingebaut werden. Die Batterie kann auf Einzelbatterien aufgeteilt und fest mit der Notleuchte verbunden sein. Diese Anordnung hat zwar den Vorteil der Dezentralisierung, welchem aber der große Nachteil der schlechten Überwachungsmöglichkeit gegenübersteht. Häufiger sind deshalb Zentralbatterien im Gebrauch, die von einer Stelle aus die ganze Anlage versorgen. Bei Neuanlagen wird man stets der Zentralbatterie den Vorzug geben.

Die gebräuchlichste Spannung beträgt 12 Volt, was einer 6zelligen Bleibatterie entsprechen würde. Für größere Anlagen werden auch höhere Spannungen verwandt. Die Notleuchten müssen so auf verschiedene Stromkreise verteilt werden, daß jeder Kreis mit max. 4 Amp. belastet wird. Die Kreise werden mit 6 Amp. einzeln abgesichert. Im Höchstfalle dürfen jedoch nur 12 Lampen je Kreis, an Einzelbatterien jedoch nicht mehr als 2 Lampen, angeschlossen werden. Die gebräuchlichsten Lampengrößen sind 5, 10, 15 und 25 Watt.

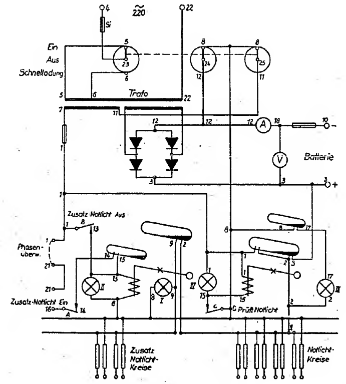
Als Mindestbrenndauer der Notbeleuchtung werden im allgemeinen 2 Stunden, im Lichtspielbetrieb jedoch 5 Stunden gefordert. Daraus ergibt sich auch die Kapazität der Batterie. Falls die Notbeleuchtung dauernd von der Batterie gespeist wird, muß die Kapazität das 1,5fache des höchsten Bedarfes in 24 Stunden betragen. Bei Theatern über 400 Plätze ist eine Zusatznotbeleuchtung erforderlich (s. Lichtspieltheater-Verordnung vom 18. 3. 1937). Die Zusatznotbeleuchtung (früher Panikbeleuchtung) muß bei Ausfall des Hauptnetzes eine ausreichende Erhellung des Zuschauerraumes, der Gänge und der Treppen sichern. Die Einschaltung der Zusatznotbeleuchtung muß selbsttätig erfolgen, auch dann, wenn nur eine Phase des Drehstromnetzes ausfällt oder in ihrer Spannung auf 70% sinkt. Außerdem muß sich diese Beleuchtung von verschiedenen bewachten Stellen des Theaters aus einschalten lassen, ohne daß sie wieder ausgeschaltet werden kann. Die Schaltstelle muß auffallend gekennzeichnet und durch Notlicht erhellt sein. Die Helligkeitsforderung an die Zusatznotbeleuchtung bestimmt die Kapazität der Batterie. Es ist jedoch zulässig, Notbeleuchtung und Zusatznotbeleuchtung von der gleichen Batterie zu speisen, wobei aber die Forderung besteht, daß alle Notleuchten einschließlich der Zusatznotbeleuchtung mindestens 3 Stunden lang brennen. Wenn z. B. die Notbeleuchtungsanlage 10 Brennstellen zu je 10 Watt hat, dann würde der Bedarf hierfür 100:12 = 8,3 Amp. sein. Für die Notbeleuchtung allein müßte dann eine Batterie von 8,3 · 5 = 41,5 Ah zugrundegelegt werden. Wenn als Zusatznotbeleuchtung 2 Lampen zu je 35 Watt benutzt werden, dann erhöht sich der Bedarf auf $\frac{100 + 70}{12} \cdot 3 = 42{,}5$ Ah. Es könnte also die gleiche Batterie verwendet werden. Im allgemeinen werden jedoch handelsübliche Batterien von 75 Ah eingebaut. Bei größeren Anlagen kommt eine 150-Ah-Batterie in Frage. In Ausnahmefällen können natürlich auch noch höhere Kapazitäten in Anwendung kommen.

Die Batterie wird am wirtschaftlichsten mit einem Gleichrichter aus dem Wechselstromnetz aufgeladen. Es empfiehlt sich, eine Pufferladung anzuwenden, weil sie die Gewähr für gute Erhaltung der Batterie bietet. Während des Betriebes wird die Batterie dauernd mit einem geringen Strom geladen, der die Selbstentladung und den Verbrauch durch Voltmeter usw. deckt. Falls die Batteriekapazität angegriffen wird, lädt der Gleichrichter bei Wiederkehr der Netzspannung selbsttätig mit hoher Stromstärke, um den Ausgleich wiederherzustellen. Um nach starken Entladungen die Batterie schnell wieder auf den alten Stand zu bringen, muß an dem Gleichrichter eine Schnelladmöglichkeit vorhanden sein. Pufferstrom und Schnelladestrom stehen in einer bestimmten Beziehung zur Batteriekapazität. Der Schnelladestrom beträgt im allgemeinen 1/10 der Kapazität, während der Pufferladestrom bei etwa 2,2 Volt pro Zelle nur 60% des maximalen Stromes beträgt.

Typ	Batterie			max. Entladestrom 3stündig	Schnellladestrom	Pufferladestrom	Gesamtleistung der Notleuchten einschl. Zusatznotleuchten
	Zellenzahl	Spannung Volt	Kapazität Ah	Amp.	Amp.	Amp.	Watt
NB 6/10	6	12	75	25	10	6,3	300
NB 6/15	6	12	150	50	15	9	600
NB 12/10	12	24	75	25	10	6,3	600
NB 12/15	12	24	150	50	15	9	1200
NB 32/10	32	64	75	25	10	6,3	1600
NB 32/15	32	64	150	50	15	9	3200

Wirkungsweise:

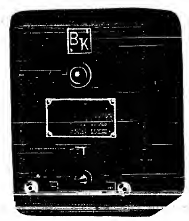
Die Umschaltung der Notbeleuchtung vom Netz auf Batterie und zurück wird von einem zuverlässig arbeitenden Umschaltrelais mit Quecksilberkontakt bewirkt. Bei größeren Anlagen



werden ein oder mehrere Schaltschütze angewendet. Durch den an der Frontplatte befindlichen Hauptschalter wird die gesamte Notbeleuchtung eingeschaltet. Eine besondere Stellung ermöglicht die Schnelladung der Batterie bei abgeschalteter Notbeleuchtungsanlage. Zur Überprüfung der selbsttätigen Umscholtvorrichtung ist ein Betätigungsknopf vorgesehen. Der jeweilige Betriebszustand (Netz oder Batterie) wird durch Signollampen angezeigt.
Ein zweiter Betätigungsknopf gestattet die Überprüfung der Zusatznotbeleuchtung, deren Einschaltung ebenfalls durch eine Signallampe angezeigt wird. Zum Überwachen der Batterie dienen ein Volt- und ein Amperemeter. Bei Drehstromanschluß kann ein Phasenüberwachungsrelais angewandt werden, welches die Umschaltung auf Batteriebetrieb und die Einschaltung der Zusatznotbeleuchtung schon bewirkt, wenn eine Phase des Drehstromnetzes ausfällt oder in ihrer Spannung auf etwa 70 % der Nennspannung absinkt. Ein solches Relais empfiehlt sich auch bei allgemeiner Gefährdung der elektrischen Anlagen (z. B. bei Freileitungsnetzen). Das Phasenüberwachungsrelais wird auf Wunsch getrennt gegen Berechnung geliefert und kann an die im Notlichtgerät vargesehenen Klemmen angeschlossen werden. Bei kleinen Anlagen bis zu 8 Notlichtstromkreisen und 2 Zusatznatbeleuchtungskreisen werden alle Sicherungen und Anschlußklemmen für die Abgänge eingebaut. Bei größeren Anlagen muß eine besondere Verteilungstafel vorgesehen werden.

Bestellbeispiel:
Anschluß 220/380 V Drehstrom, 4 Notlichtkreise, 1 Zusatznotlichtkreis, Leistung: Notlicht 190 W, Zusatznotlicht 70 W, 6-Zellen-Bleibatterie, 75 Ah, 10 A max. Ladestrom = NB 6/10.

Lieferwerk: 112



TROCKEN-LADEGLEICHRICHTER PL. 803

zur Ladung von 6- und 12-Volt-Blei- oder Stahlbatterien.

Das Gerät gibt bei 6 Volt Nenn-Gleichspannung 6 Ampere Ladestrom bzw. bei 12 Volt Nenn-Gleichspannung 4 Ampere Ladestrom ab und ist besonders für Licht- und Starterbatterien mittlerer Kraftwagen geeignet, desgl. für Natbeleuchtungsbatterien.

Das vollständige Gerät besteht aus

Wechselstrom-Anschlußklemmen – Transformator mit getrennten Wicklungen – Selen-Ventil-System – Kontroll-(Glimm-)Lampe – Gleichstromsicherung – Gleichstrom-Kordelklemmen – Umschalter in gemeinsamem Metallgehäuse.

Technische Angaben:

Das Gerät wird für zwei Anschlußspannungen geliefert:
110 ... 120 und 220 ... 230 Volt 50 Hz
(umklemmbar an den Wechselstrom-Anschlußklemmen).
Für zwei Gleichspannungen umschaltbar – 6 oder 12 Volt – entsprechend 3 oder 6 Bleizellen.
Der Ladestrom beträgt bei der Leistung 6 Volt 6 Ampere und bei 12 Valt 4 Ampere.
Die maximale Gleichstromleistung von 6 bzw. 4 Ampere versteht sich bei Beginn der Ladung, d. h. bei etwa 2 Volt je Bleizelle. Mit ansteigender Batteriespannung fällt die Ladestromstärke allmählich ab und beträgt am Ende der Ladung etwa 40 % des Anfangsladestromes. Dieser Ladeverlauf gewährleistet eine weitgehende Schonung der Batterie.

Typ	Wechselstrom-Netzanschluß	Gleichstromleistung	Gewicht ca. kg	Abmessungen ca. mm
803	110/220 Volt	6/12 V 6/4 Ampere	4,5	210 × 165 × 140

Angebote für Lieferung von Trocken-Gleichrichtern anderer Größen und Leistungen für alle Verwendungszwecke auf besondere Anfrage.

Lieferwerk: 437

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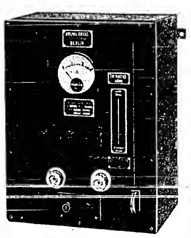


TROCKEN-LADEGLEICHRICHTER PL. 810

mit einem Ladekreis, für vier Spannungsstufen umschaltbar, mit Amperemeter, Schalter, Gleich- und Wechselstrom-Sicherungsautomaten und Regelwiderstand.

Das Gerät gibt bei 2 bis 48 Valt Nenn-Gleichspannung einen maximalen Ladestram von 10 Ampere ab und ist besonders für Ladestationen oder Fuhrparks geeignet.

Das vollständige Gerät besteht aus

Wechselstram-Anschlußklemmen – Wechselstromsicherung – 3 pol. Paketschalter (2 pol. Wechselstrom, 1 pol. Gleichstrom) – Umspanner mit getrennten Wicklungen – vierstufigem Umschalter – Selen-Ventil-System – Regelwiderstand (von außen bedienbar) – Gleichstromsicherung – Drehspul-Strommesser – Gleichstram-Anschlußklemmen – gemeinsamem Metallgehäuse für Wandaufhängung.

Technische Angaben:

Das Gerät wird für zwei Anschlußspannungen geliefert:
110 und 220 Valt 50 Hz
(umklemmbar am Transformotar).

Durch einen vierstufigen Umschalter sind vier Gleichspannungen entsprechend der Ladung von 6, 12, 18 ader 24 Bleizellen einstellbar. Durch den van außen zugänglichen Regelwiderstand kann die Gleichspannung in der 12-Valt-Stufe sa weit herabreguliert werden, daß eine einzellige Bleibatterie mit 25 % des Nennstrames geladen werden kann, weiterhin kann in jeder Spannungsstufe der Anfangsladestram bis auf 20 % des maximalen Strames herabgesetzt werden.

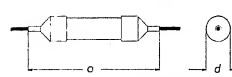
Typ	Wechselstrom-Netzanschluß	Gleichstromleistung	Gewicht ca. kg	Abmessungen ca. mm
810	110/220 Valt	12/24/36/48 V 10 Ampere 2–48 V 1–10 A regelbar	25	480 × 375 × 265

Angebate für Lieferung von Tracken-Gleichrichtern anderer Größen und Leistungen für alle Verwendungszwecke auf besandere Anfrage.

Lieferwerk: 437

KUPFEROXYDUL-GLEICHRICHTER FÜR HOCHFREQUENZ

TYP S 1b S 5b S 10b



Typ	a	d
S 1 c	~ 23	6
S 5 b	~ 32	6
S 10 b	~ 32	6

Verwendung: Der Kupferoxydul-Gleichrichter für Hochfrequenz dient in der Rundfunk- und Meßtechnik den verschiedensten Zwecken. Er wird verwendet als Detektor oder Audianersatz, in Schwundausgleichsschaltungen, in Anodenstrom-Sparschaltung, zur Dynomikentzerrung, Lautstärkeregelung und Amplitudenbegrenzung in der NF-Stufe, als Sperrventil, zum Überspannungsschutz usw.

Aufbau: Die Kupferaxydul-Gleichrichtertabletten sind in einem Isolierstoffröhrchen in Einwegschaltung untergebracht. Die Enden des Röhrchens sind durch Kappen mit eingelöteten Anschlußdrähten verschlossen. Die Säule gleicht einem Hochohmwiderstand und kann wie dieser bei der Montage freitragend eingebaut werden.

Wirkungsweise: Die Gleichrichtersäule zeichnet sich durch eine äußerst geringe Eigenkapazität aus, die beispielsweise für den Typ S 5 b im Mittel 30 pF, gemessen bei 500 kHz und 10 V Gleichspannung am Belastungswiderstand von 1 MΩ beträgt.

Typ	Belastbar mit Gleich-stram		Zulässige Spitzen-spannung	Anzahl der Tabletten	Tabletten-größe	Gewicht	Liefer-werk
	Gleich-stram mA	Wechsel-spannung Veff.*)	V max.		mm Ø	ca. g	
S 1 b	0,25	2,5	6	1	2	3	
S 5 b	0,25	12,5	30	5	2	4	215
S 10 b	0,25	25	60	10	2	5	

*) Für höhere Spannungen auf Anfrage.

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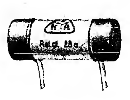
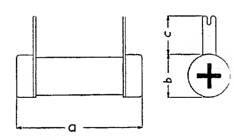
IKA-KUPFEROXYDUL-GLEICHRICHTER FÜR FERNMELDEZWECKE TYP Rel gl ... Bv ...





Verwendung: Die Kupferoxydul-Gleichrichter für Fernmeldezwecke werden in Fernmelde- und Fernsteuer-Systemen verwendet zur Gleichrichtung von Ton- und Hochfrequenzströmen zur Modulation und Demodulation sowie als sonstige nichtlineare Widerstände (z. B. Amplituden-Begrenzer).

Typ	a	b	c
Rel gl 33 Bv 430/1	30	6,9	8
Rel gl 26 Bv 436/1	30	6,9	8
Rel gl 28 Bv 433/1	30	10,9	10

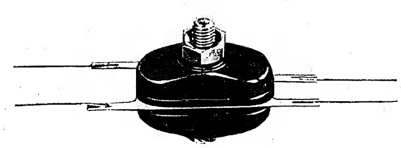
Aufbau: Die Kupferoxydul-Gleichrichtertabletten sind in einem Porzellanröhrchen untergebracht, deren Verschlußkappen aufgelötet sind. Die an den Verschlußkappen befindlichen Lötfahnen dienen der Stromzuführung. Zwischenscheiben und Druckfedern halten die Gleichrichterscheiben fest und gewährleisten dadurch guten Kontakt. Die Gegenelektrode der Kupferoxydulschicht ist ein Silberbelag. Hierdurch wird eine hohe Konstanz der elektrischen Werte erreicht.

Wirkungsweise: Bei der Verwendung der Säule als Gleichrichter beruht die Wirkungsweise auf der unipolaren Leitfähigkeit der Tablette, während für Modulationszwecke die starke Spannungsabhängigkeit des Tablettenwiderstandes im Bereich kleiner angelegter Wechselspannungen zur Wirkung kommt.

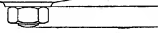
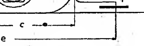
Typ	Spitzenspannung V	Nenngleichstrom*) mA	Anzahl der Tabletten**)	Tablettengröße mm ∅	Gewicht ca. g
Rel gl 33 Bv 430/1	2	0,25	1	2	5
Rel gl 26 Bv 436/1	2	1	1	3	5
Rel gl 28 Bv 433/1	2	10	1	7	9

*) Die angegebenen Stromwerte sind Höchstwerte. Sie sind mit Rücksicht auf das konstante Verhalten der Gleichrichter möglichst weitgehend zu unterschreiten.
**) Kupferoxydul-Gleichrichter für Fernmeldezwecke mit mehr als einer Tablette auf Anfrage

Lieferwerk: 215



IKA-KUPFEROXYDUL-GLEICHRICHTER FÜR MESSZWECKE TYP G...21/1 G...41/1

Typ	Wirkschaltplan
G 1421/1	
G 1721/1	
G 1921/1	
G 1441/1	
G 1741/1	
G 1941/1	

Verwendung: Kupferoxydul-Gleichrichter haben in der Meßtechnik die Aufgabe, den zu messenden Wechselstrom in Gleichstrom umzuformen. Dadurch werden die Vorzüge der Drehspulinstrumente auch der Wechselstrom-Messung zugänglich gemacht. Die Forderungen nach größtmöglicher Konstanz der Strom- und Spannungskennlinie, weitestgehender Frequenz-Unabhängigkeit, möglichst kleiner Bauform zum Einbau in die Gehäuse der Meßgeräte sind bei den Kupferoxydul-Gleichrichtern für Meßzwecke in vollem Umfang erfüllt.

- blau
+ rot
~1 gelb
~2 violett

Typ	a	b	c	d	e
G 1421/1	13,5	23	26	12	46
G 1721/1	15,5	25	28	13	48
G 1921/1	18,5	29	30	14	50
G 1441/1	14	23	26	12	46
G 1741/1	16	25	28	13	48
G 1941/1	19	29	30	14	50

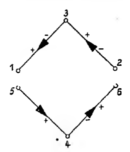
Aufbau: Die Kupferoxydul-Gleichrichtertabletten sind in einer der Schaltung entsprechenden Anzahl in einem gedrungenen Preßstoffgehäuse untergebracht. Zwischenscheiben und Anpreßfedern gewährleisten eine sichere Lagerung der Tabletten und guten Kontakt. Eine erhöhte Sicherheit hinsichtlich der Kontaktgabe und des schädlichen Einflusses der Luftfeuchtigkeit wird durch einen auf die Kupferoxydulschicht aufgebrachten Silberbelag erreicht.

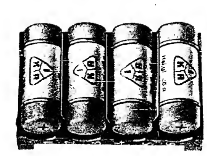
Wirkungsweise: Es empfiehlt sich, die Meßgleichrichter nur mit den angegebenen Nennströmen und mit möglichst geringer Spannung unterhalb der maximalen Gleichspannung zu belasten. Durch höhere Spannung, etwa bis zur dreifachen maximalen Spannung, wird der Gleichrichter auch im Dauerbetrieb nicht beschädigt. Er gilt aber dann wegen der größeren Fehler nicht mehr als Meßgleichrichter.

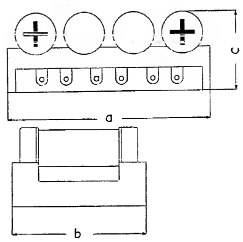
Typ	Gleichstrombelastung mA	Gleichspannung*) V max.	Tablettengröße mm Ø	Gewicht ca. g	Lieferwerk
		Einwegschaltung mit Mittelabgriff			
G 1421/1	1	1	3	11	215
G 1721/1	5	1	5	13	
G 1921/1	10	1	7	16	
		Einphasen-Brückenschaltung			
G 1441/1	1	0,5	3	11	
G 1741/1	5	0,5	5	13	
G 1941/1	10	0,5	7	16	

*) Für höhere Spannungen auf Anfrage.

IKA-RINGMODULATOREN TYP M 111/....







Typ	a	b	c
M 111/3	50	32	14
M 111/7	50	32	19

Verwendung: Der Ringmodulator wird zur Modulation und Demodulation in Trägerfrequenzsystemen für Fernmelde- und Fernsteuerzwecke verwendet.

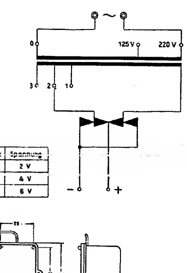
Aufbau: Auf einer Bakelitplatte sind 4 Kupferoxydul-Gleichrichtersäulen für Fernmeldezwecke montiert und in Ringmodulator-Schaltung verdrahtet.

Wirkungsweise: Die zusammengefaßten Gleichrichtersäulen sind in ihren Kennlinien so ausgewählt und in Gruppen gepaart, daß die in der Tabelle angegebenen Werte für die Trägerdämpfung und den Wellenwiderstand eingehalten werden.

Typ	Nennspannung Veff.	Träger-Dämpfung in beiden Richtungen N	Wellenwiderstand Z Ω	Tablettengröße*) mm	Gewicht ca. g	Lieferwerk
M 111/3	0,5	≧ 4,2	6000	3	27	215
M 111/7	0,5	≧ 4,2	600	7	43	

*) Ringmodulatoren mit abweichenden Tablettengrößen und mehr als einer Tablette je Säule auf Anfrage.

IKA-LADE-TROCKENGLEICHRICHTER



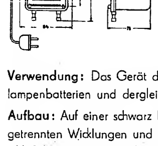
Stufe	Spannung
1	2 V
2	4 V
3	6 V

Kleinladegerät

Typ: **LGe 6/0,5 us**

Anfangsladespannungen: 2, 4, 6 Volt

Wechselstrom-Anschlußspannung:
220, 125 Volt; 50 Per/s



Verwendung: Das Gerät dient zum Laden kleiner Auto-, Motorrad-, Notstrom-, Handlampenbatterien und dergleichen mit 1 ... 3 Bleizellen.

Aufbau: Auf einer schwarz lackierten Grundplatte sind aufgebaut: der Transformator mit getrennten Wicklungen und der Kupferoxydul-Säulensatz in Brückenschaltung sowie die Anschlußklemmen für die Batteriezuleitung. Das Gerät ist zum Anschluß an die Wechselspannung mit Schnur und Stecker versehen; es ist kurzschlußsicher, daher ohne Sicherungen. Die Kappe besteht aus schwarzem Preßstoff.

Wirkungsweise: Die Umschaltung auf die Gleichspannung 2, 4 und 6 Volt wird an der im Inneren befindlichen Klemmleiste Stufe 1 ... 3 vorgenommen. Zur Inbetriebnahme wird nach Anschluß der Batterie nur der Stecker in die Lichtsteckdose eingesteckt.

Typ	Anfangsladespannung Volt	Anfangsladestrom bei 10-Stunden-Betrieb Ampere max.	Gewicht ca. kg	Lieferwerk
LGe 6/0,5 us	2, 4, 6	0,5	0,75	215

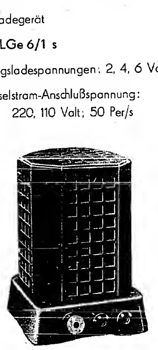
IKA-LADE-TROCKENGLEICHRICHTER

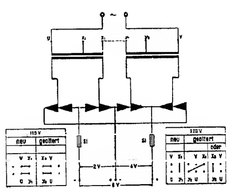
Heimladegerät

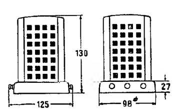
Typ: LGe 6/1 s

Anfangsladespannungen: 2, 4, 6 Volt

Wechselstrom-Anschlußspannung:
220, 110 Volt; 50 Per/s





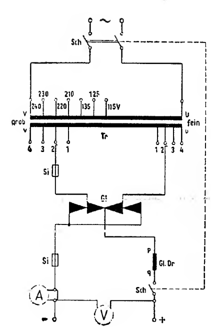


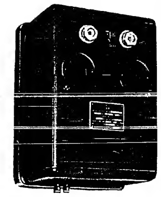
Verwendung: Das Gerät dient zum Laden kleiner Auto-, Motorrad-, Notstrom-, Handlampenbatterien und dergleichen mit 1 . . . 3 Bleizellen.

Aufbau: Der Transformator mit getrennten Wicklungen, der Kupferoxydul-Säulensatz in Brückenschaltung, Sicherungen für den Sekundärstromkreis und Anschlußklemmen sind auf einer Grundplatte aus lackiertem Stahlblech untergebracht. Die Kappe ist aus Stahlblech gefertigt und allseitig perforiert.

Wirkungsweise: Das Gerät ist nach dem Anschalten an die Wechselspannung sofort betriebsfähig. Abgriff der drei verschiedenen Gleichspannungen erfolgt an den drei Gleichspannungsklemmen.

Typ	Anfangs-ladespannung Volt	Anfangsladestrom bei 10-Stunden-Betrieb Ampere max.	Gewicht ca. kg	Lieferwerk
LGe 6/1 s	2, 4, 6	1	1,5	215





IKA-FERNMELDE-TROCKENGLEICHRICHTER

Typ FGe 4/0,3 r FGe 6/0,7 r FGe 24/0,7 r
FGe 4/1,2 r FGe 6/4 r FGe 24/1,5 r

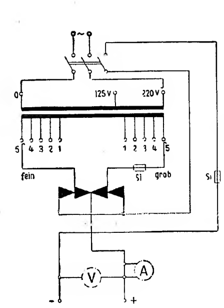
Batterie-Nennspannung: 4, 6, 24 Volt

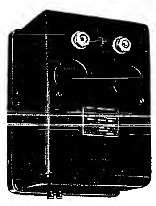
Wechselstrom-Anschlußspannungen: 240, 230, 220, 210, 135, 125, 115 Volt; 50 Per/s

Verwendung: Laden von 2-, 3- bzw. 12zelligen Bleibatterien für Fernmelde-, vorwiegend Fernsprechanlagen im Pufferbetrieb.

Aufbau: Der Transformator mit getrennten Wicklungen, die Glättungsdrossel, der Kupferoxydulsäulensatz in Brückenschaltung, ein dreipoliger Kippschalter, durch den der Transformator zweipolig vom Netz abgeschaltet, der Gleichstromkreis einpolig unterbrochen wird, und je eine Sicherung im Sekundär- und im Gleichstromkreis sind in einem stabilen, lackierten Stahlblechgehäuse eingebaut. Das Gerät ist für Wandaufhängung bestimmt.

Wirkungsweise: Die Geräte dürfen nur an geladene oder vorgeladene Batterien angeschlossen werden. Die Spannung der Batterien muß mindestens 4,6 bzw. 12 Volt betragen. Nach Anschluß der Batterie und des Verbraucherstromkreises ist das Gerät betriebsbereit.





IKA-LADE-TROCKENGLEICHRICHTER

Typ LGe 6/5 s   Typ LGe 12/10 s
Typ LGe 12/6 s   Typ LGe 24/6 s

Anfangsladespannung: 6, 12, 24 Volt

Wechselstrom-Anschlußspannung: 220, 125 Volt; 50 Per/s

Verwendung: Die Geräte dienen zum Laden von 3-, 6- und 12zelligen Bleiakkumulatoren mit Anfangsladeströmen von 5, 6 bzw. 10 Ampere. Falls ununterbrochene Ladezeiten von mehr als 10 Stunden je Tag erforderlich sind, muß der Anfangsladestrom durch Umklemmen am Transformator auf die für Dauerbetrieb zulässigen Werte herabgesetzt werden.

Aufbau: Der Transformator mit getrennten Wicklungen, der Kupferoxydul-Säulensatz in Brückenschaltung, die Sicherungen für den Sekundär- und den Gleichstromkreis, die Anschlußklemmen und ein dreipoliger Kippschalter, durch den der Transformator zweipolig vom Netz abgeschaltet und der Gleichstromkreis einpolig unterbrochen wird, sind in einem stabilen, lackierten Stahlblechgehäuse eingebaut. Zwecks guter Durchlüftung des Säulensatzes ist das Gehäuse teilweise perforiert.

Die Geräte sind für Wandaufhängung bestimmt.

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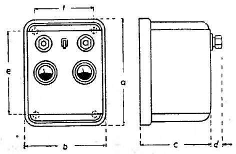
Wirkungsweise: Nach Anschluß der Batterie und Einschalten des Kippschalters setzt der Ladevorgang ein.

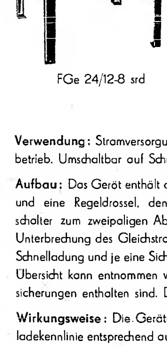
Typ*)	Anfangs-ladespannung Volt	Anfangsladestrom bei 10-Stunden-Betrieb Ampere max.	Anfangsladestrom bei Dauerbetrieb Ampere max.	Gewicht ca. kg	Lieferwerk
LGe 6/5 s	6	5	4	4,7	215
LGe 12/6 s	12	6	4	12,8	
LGe 12/10 s	12	10	7	14,8	
LGe 24/6 s	24	6	4	16,8	

*) Sämtliche Typen sind je nach Wunsch ohne oder mit eingebauten Meßinstrumenten mit Drehspulmeßwerk lieferbar.

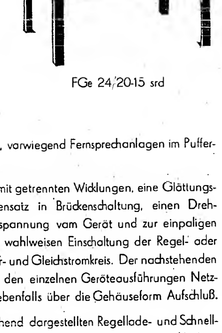


Typ	a	b	c	d	e	f
LGe 6/5 s	228	178	160	25	191	132
LGe 12/6 s	338	248	185	25	296	206
LGe 12/10 s LGe 24/6 s	446	338	185	25	404	296

Maße in Millimetern



FGe 24/12-8 srd



FGe 24/20-15 srd

Verwendung: Stromversorgung von Fernmelde-, vorwiegend Fernsprechanlagen im Pufferbetrieb. Umschaltbar auf Schnelladung.

Aufbau: Das Gerät enthält den Transformator mit getrennten Wicklungen, eine Glättungs- und eine Regeldrossel, den Kupferoxydulsäulensatz in Brückenschaltung, einen Drehschalter zum zweipoligen Abschalten der Netzspannung vom Gerät und zur einpoligen Unterbrechung des Gleichstromkreises sowie zur wahlweisen Einschaltung der Regel- oder Schnelladung und je eine Sicherung im Sekundär- und Gleichstromkreis. Der nachstehenden Übersicht kann entnommen werden, wie weit in den einzelnen Geräteausführungen Netzsicherungen enthalten sind. Die Übersicht gibt ebenfalls über die Gehäuseform Aufschluß.

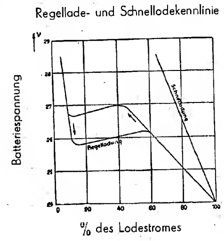
Wirkungsweise: Die Geräte sind der nachstehend dargestellten Regellade- und Schnellladekennlinie entsprechend ausgelegt. Sie dürfen daher nur an geladene oder vorgeladene Batterien angeschlossen werden. Durch die „Schnelladung" ist die Möglichkeit gegeben, bereits in Betrieb befindliche Batterien nach dem Aussetzen des Netzstromes schnell aufzuladen und auch Erstladungen von Batterien über Vorwiderstände vorzunehmen. Nach Anschluß der Batterie und des Verbraucherstromkreises ist das Gerät betriebsbereit.

Typ *)	Batteriespannung	Lodestromstärke bei		Töglicher Strombedorf der Anlage	Größe der Batterie (Pufferbetrieb)	Größe des bei Erstoufladung erforderlichen Regelwiderstandes	Stromstärke der Sicherungen (TdZ-Si)		
		Regelladung	Schnellladung				Netzsicherung instollationsseitig vorzunehmen	Netzsicherung im Gerät vorhonden	Gleichstromseitige Sicherung
	Volt	Ampere	Ampere	Ah	Ah	Ω	Ampere	Ampere	Ampere
FGe 24/4–3 srd	24	3	8	36	72	7	4	—	6
FGe 24/8–5 srd	24	5	8	60	108	4	6	—	15
FGe 24/12–8 srd	24	8	12	96	144	3	10	—	25
FGe 24/20–15 srd	24	15	20	180	288	1,5	—	20	35

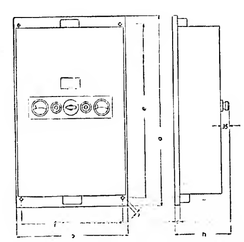
*) Sämtliche Typen sind je nach Wunsch ohne oder mit eingebouten Meßinstrumenten mit Drehspulmeßwerk lieferbor.

Typ	Gewicht ca. kg
FGe 24/4–3 srd	32
FGe 24/8–5 srd	70
FGe 24/12–8 srd	100
FGe 24/20–15 srd	140

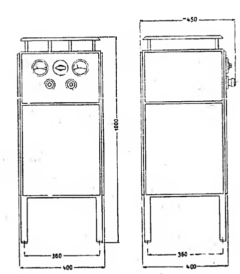
Regellade- und Schnellodekennlinie



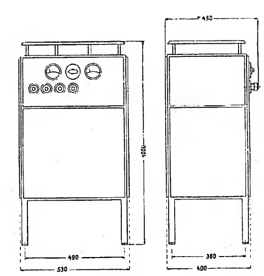
Lieferwerk: 215



Typ	a	b	c	d	e	f	h
FGe 24/4-3 srd	690	415	20	9	650	375	210
FGe 24/8-5 srd	790	415	25	9	750	375	215

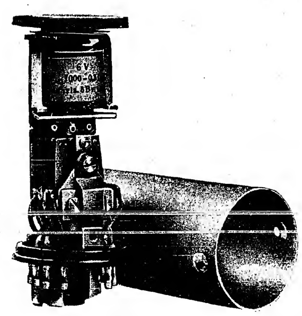


FGe 24/12–8 srd



FGe 24/20–15 srd

Lieferwerk: 215



ZERHACKER MIT TREIBKONTAKT

Technische Daten

Betriebs-spannung	max. Schaltleistung als WR	WGL	Bestell-Nr. als WR oder WpZ	WGL
2,4 V	14 W	8 W	1188.001–10.001	1188.001–10.011
4 V	24 W	14 W	1188.001–10.002	1188.001–10.012
4,8 V	27 W	16 W	1188.001–10.003	1188.001–10.013
6 V	35 W	20 W	1188.001–10.021	
12 V	70 W	40 W	1188.001–10.022	
24 V	100 W	80 W	1188.001–10.023	
60 V	100 W	100 W	1188.001–10.031	
110 V	100 W	100 W	1188.001–10.031	
220 V	100 W	100 W	1188.001–10.031	

Frequenz: 115 Hz ± 5 %
Max. Schaltspannung: 220 V
max. Schaltstrom je Kontaktpaar: als WR 3 A, WGL 3,5 A

Schließzeit: 40 % ± 3 %
Kontaktmaterial für die Arbeitskontakte: Wolfram bzw. Silber
Einbaulage: senkrecht

Maße: Länge 87 mm, Durchmesser 41,5 mm
Gewicht: ca. 0,140 kg

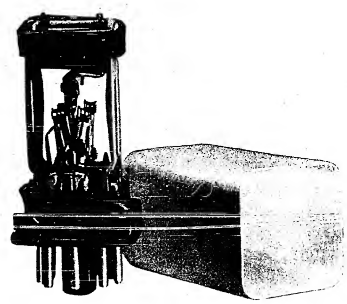
Beschreibung umseitig

Lieferwerk: 454

Beschreibung

Der Zerhacker dient zur Umformung von Gleich- in Wechselstrom. Je nach Schaltung im Netzteil (Transformator mit Sieb-, Entstör- und Funkenlöschgliedern) kann er als Wechselrichter oder Wechselgleichrichter verwendet werden.

Verwendungszweck: Spannungsumformung für fahrbare, tragbare oder stationäre Geräte der Nachrichtentechnik.



ZERHACKER MIT TREIBKONTAKT

Technische Daten

Betriebsspannung	max. Schaltleistung als WR	max. Schaltleistung als WGL	Bestell-Zeichen als WR	Bestell-Zeichen als WGL
2,4 V	—	4 W	—	WGL 2,4
4 V	—	8 W	—	WGL 4
6 V	15 W	10 W	WR 6	WGL 6
12 V	30 W	20 W	WR 12	WGL 12

Zulässige Schwankung der Betriebsspannung:	± 10 %
Frequenz:	115 Hz ± 0,5 %
max Schaltspannung:	230 V
max. Schaltstrom je Kontaktpaar:	2 A als WGL, 1,5 A als WR
Schließzeit:	40 % ± 4 %
Treiberleistung:	ca. 0,5 W
Kontaktmaterial für die Arbeitskontakte:	Wolfram, unter 6 V primär. Silber
Einbaulage:	senkrecht
Maße:	Ø 36 × 36, Länge 85 mm
Gewicht:	ca. 100 g

Beschreibung umseitig

Lieferwerk: 454

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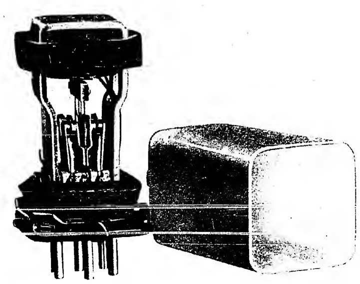
Beschreibung

Der Zerhacker dient zur Umformung von Gleich- in Wechselstrom. Je nach Schaltung im Netzteil (Transformator mit Sieb-, Entstör- und Funkenlöschgliedern) kann er als Wechselrichter oder Wechselgleichrichter verwendet werden.

Verwendungszweck: Spannungsumformung für fahrbare, tragbare oder stationäre Geräte der Nachrichtentechnik.



ZERHACKER OHNE TREIBKONTAKT

Technische Daten

Betriebsspannung	max. Schaltleistung WGL	Bestell-Zeichen WGLa
4,5 V	9 W	WGLa 4,5
6 V	12 W	WGLa 6
12 V	24 W	WGLa 12

Zulässige Schwankung der Betriebsspannung: ± 10 %
Frequenz: 150 Hz ± 10 %
max. Schaltspannung: 250 V
max. Schaltstrom je Kontaktpaar: 2 A

Treiberleistung: ca. 0,5 W
Kontaktmaterial für die Arbeitskontakte: Wolfram
Einbaulage: senkrecht

Maße: ∅ 36 × 36, Länge 85 mm
Gewicht: ca. 100 g

Beschreibung umseitig

Lieferwerk: 454

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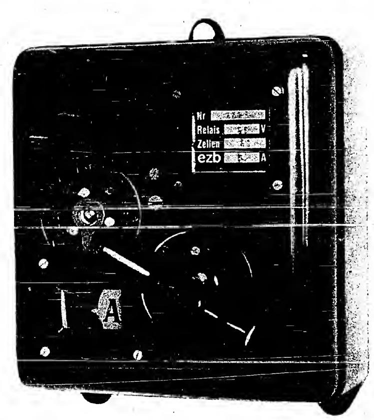
Beschreibung:

Der Wechselgleichrichter dient in Verbindung mit dem Transformator, den Sieb-, Entstör- und Funkenläschgliedern, zur Umfarmung von Gleich-Batteriespannung 4, 5, 6 und 12 V in Gleichspannung max. 250 V. Bei Verdapplerschaltung bis max. 500 V, vom Transfor-matar abhängig.

Verwendungszweck: Spannungsumformung für fahrbare, tragbare ader stationäre Geräte der Nachrichtentechnik.



SELBSTTÄTIGER LADESCHALTER

(System Pähler)

Der selbsttätge Ladeschalter (System Pähler) wird zur unbeaufsichtigten Ladung von Batterien verwendet.

Der Ladeschalter besteht im wesentlichen aus einem Ausschalter, einem Relais und einem Uhrwerk.

Wirkungsweise: Die Wirkungsweise des Pähler-Schalters beruht auf zwei wesentlichen Eigenschaften der Bleiakkumulatoren:

1. Sobald eine Akkumulatorenzelle die Spannung von 2,4 V erreicht hat, wird bis zur völligen Aufladung immer die gleiche Strommenge, also bei gleichbleibender Ladestromstärke eine gleichbleibende Restladezeit (Nachladezeit), gebraucht.
2. Die Ladespannung steigt bei Erreichen von 2,4 V fast sprunghaft auf 2,6 V und darüber.

Diesen Spannungssprung benutzt man, um ein Relais zum Ansprechen zu bringen. Das Relais setzt ein Uhrwerk in Gang, das nach einer bestimmten einstellbaren Zeit von $^1/_2$ bis 6 Stunden den Ausschalter auslöst und damit den Ladestrom unterbricht.

Bei Bestellung angeben: Fabrikat, Form und Kapazität der zu ladenden Batterie, Anzahl der Elemente, Anzahl der mit dem bestellten Ladeschalter gleichzeitig zu ladenden Batterien.

Abschaltleistung: Spannungsunterschied zwischen Batterie- und Ladespannung V 220 110
Zulässiger Abschaltstrom A 20 60

1 = Hauptkontakte
2 = Uhrwerk
3 = Zeiteinstellung
4 = Spannungsrelais
5 = Vorwiderstand für das Spannungsrelais
N 1, N 2 = Kontakte für die Betätigung eines Schaltmagneten
P 1, P 2, P 3, R 2 = Hilfsklemmen
SL 1, SL 2 = Hauptkontakte

Schutzart: P 30 für Ladeschalter mit Schutzhaube.

Anschlüsse für die Hauptleitung bei der Ausführung mit Schutzhaube nur rückseitig durch Bolzen für höchstens 16 mm^2.

Bestell-Nr.	Ausführung	bis A	Zellenzahl	Gewicht netto ca. kg	Lieferwerk
260 100	mit $^1/_2$ ... 6stündiger Uhrlaufzeit	60	bis 80 Zellen	2,7	302
			über 80 Zellen bis zu einer höchsten Batteriespannung von 500 V einschl. besonderen Vorwiderstandes	3,7	

RFT TABLE TELEPHONE TYPE W 38

Postal type W 38 for CB and automatic dialling service

The electric properties and the mechanism correspond to the prescriptions of the German Postal Authorities. The different parts are in accordance with these postal standards and can thus easily be replaced.
The implement is equipped with terminals for a second bell and for an additional receiver.
It can be equipped with or without earthing key. The main parts (except the number switch) are mounted on a common metallic base plate.
The number switch is arranged in the casing. When dialling, it emits two blind impulses after each number for avoiding any failures which might occur when the finger holes are operated too quickly.
Both the microphone and the receiver cap can be changed. If the telephone is to be delivered with a second bell, it must be equipped with a four-thread vord instead of a three-thread cord. Junction box with disconnecting plugs for disconnecting the A- and B-leads. Plastic casing, black, or upon special request also in other colours.

Operating voltage: 24 – 60 volts

Dimensions: about 240×180×155 mm (about $9^1/_2$×7×6 inches)

Adaptation resistance: about 600 ohms

Weight: about 2,1 kg (about 4 lbs. 10 ozs.)

DEUTSCHER INNEN- UND AUSSENHANDEL · ELEKTROTECHNIK

RFT TABLE TELEPHONE TYPE W 38

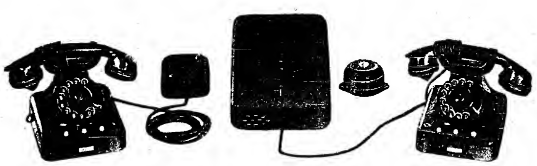
Postal type W 38 in a black plastic casing with and without earthing key for CB and automatic dialling service. – Switching appliances and design in accordance with the prescriptions of the German Postal Authorities.

All single parts in accordance with postal standards, mounted on a common metallic base plate.

It is possible to connect a second bell (outside bell) and a second single receiver. Both the receiver and the talking box can be changed.

Three- or four-thread connecting cord, junction box with disconnecting plugs in the a- and b-lines.

Weight: about 2,0 kg (about 4 lbs. 6 ozs.)



RFT ANTECHAMBER TELEPHONE TYPE DP 573

The RFT antechamber telephone DP 573 has been developed for connection to a trunk line for current conduction type DP 573 S 1. This system makes it possible to receive the arriving trunk or indoor telephonate at the so-called secretary station and, if required, to pass it on to the station of the principal. Thus there will be given any guarantee for that the user of the principal's station will not be troubled by calls which can already be settled by the secretary station. Moreover intercommunication between the two stations is possible, no matter whether there is going on another telephonate or not.

Furthermore the secretary, upon request, can take over a telephonate which is lying on the principal's station.

If the plant is connected to an existing sub-station arrangement, enquiries can be made within this plant in the same way as with a normal table station. In case the antechamber station is temporarily unattended, it can be switched over to the principal's station by means of the nightswitch which is arranged within the reach of the secretary station.

The antechamber telephone DP 573 consists of two stations of the same type, which is the RFT table telephone W 38 with the only difference that they have two keys and two control signs more than the latter, as well as a supplementary box and a second A. C. box-type bell. The plant is fed by a battery with a working voltage of 24 resp. 60 volts. The two stations are interconnected by a six-couple cable.

1 trunk line

Intercommunication between the two stations

Enquiries possible in case of connection to sub-stations.

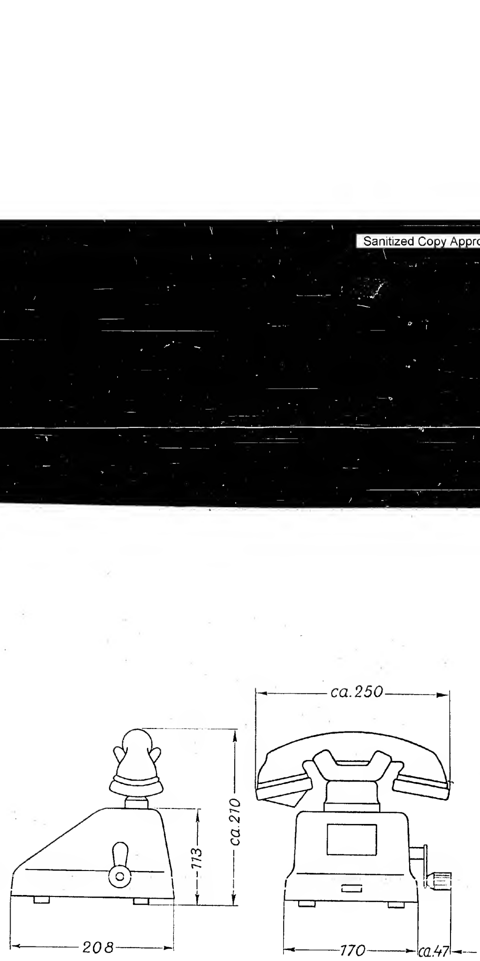
Night switch

Operating voltage: 24 resp. 60 volts

Weight: about 10.5 kg (about 23 lbs.)

RFT TELEPHONE TYPE OB

The OB telephone (OB means LB = Local battery) can be connected to LB trunk stations as well as to home speaking devices.
It consists of a base plate, on which there are fixed the different parts, such as the inductor, the alarm system, the induction coil, the condenser, the ledge with the terminals etc. The whole mechanism is covered by a protective cap with a fork supporting the hand apparatus. Switching over from calling position to speaking position is effected by lifting the hand apparatus.
The speaking current is taken from a local battery, while the calling current is produced by an inductor.



By a corresponding alteration of a connecting link on the ledge with the terminals, it is possible to switch the telephone in such a way as to make the bell ring or hush when calling (operating the crank).

Alarm system: 2 × 750 ohms 11 000 Wd. 0,11 Cul.
or: 2 × 3000 ohms 22 000 Wd. 0,08 Cul.

Operating voltage: 2 – 3 volts D. C.

Inductor: 400 ohms

Weight: about 3,7 kg (about 8¼ lbs.) with cap.

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GAS-DISCHARGE LAMPS AND COMPOUND LAMPS

Group 48

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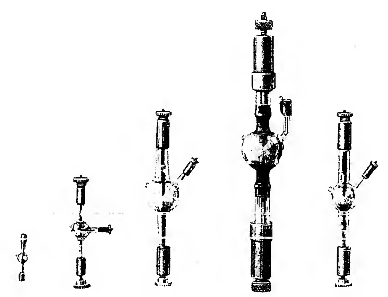


Picture 1 2 3 4 5

MAXIMUM-PRESSURE MERCURY VAPOUR TUBES

are space-saving sources of light that are favourably applied in places where luminous currents together with maximum density of light are required. Constant size and position of the burning spot, non-flaring and freedom from variations of the luminous intensity are some of the advantages of these tubes.

The light of the standard lamps is bluish-white. One type is also available with improved colour of light (increased percentage of red and blue).

The tubes have a spherical burner of quartz glass and bear sockets at the two ends. On account of the high working pressure and the intensive ultraviolet radiation, the tubes must be provided with a proper protection device.

The standard types may be used in cinema projectors, reproduction sets, small flashlights and for cinema studio illumination. The colour-improved type is the suitable source of light in places where a true-to-nature reproduction of the colours is required, e. g., for colour films.

Like all gas-discharge tubes, the maximum-pressure mercury vapour tubes are connected via a choke or a resistor. All the tubes are ignited by means of an ignition coil with the exception of the 50-W-tube, HBO 50, starting without an ignition coil.

Type	Electrical Data				Lighting Data				Total Length	Picture No.	Approx. Grammes
	Wattage [1]	Feeding Voltage	Burning Voltage	Operation Current	Mean Density of Light	Luminous Area [2] mm inch.	Candle Power [3]	Luminous Efficiency	mm inch		
	W	V	V	A	sb		cd	lm			
With minimum dimensions, high luminous intensity and point-formed luminous area											
HBO 50	50	220 AC	35...50	1,2...1,7	20000	0,6x1,2 $^{1}/_{64}$x$^{3}/_{64}$	ca. 230	ca. 1700	46 1$^{13}/_{16}$	1	3
With extremely high luminous efficiency and high luminous intensity											
HBO 200	200	110 DC 220 AC	55...75	2,7...3,7 2,9...4,0	23000	1,4x2,5 $^{1}/_{16}$x$^{3}/_{32}$	ca. 1000	ca. 8500	100 4	2	36
HBO 500	500	110 DC 220 AC	70...90	5,6...7,1 6,1...7,9	20000	2.5x4.5 $^{3}/_{32}$x$^{3}/_{16}$	ca. 2400	ca. 22000	170 6$^{3}/_{4}$	3	70
HBO 1000	1000	220 AC	70...90	12,2...15,7	30000	2,8x5,8 $^{1}/_{8}$x$^{7}/_{32}$	ca. 6000	ca. 50000	265 10$^{1}/_{2}$	4	185
With high luminous efficiency, improved colour of light and high luminous intensity											
HBO 510	500	110 DC 220 AC	70...95	5,3...7,1 5,8...7,9	18000	2,5x4,5 $^{3}/_{32}$x$^{3}/_{16}$	ca. 2200	ca. 18000 [4]	170 6$^{3}/_{4}$	5	70

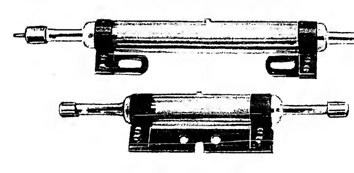
All types require an inclination from vertical to 45° for correct burning.

[1] without preset

[2] arc width × length of arc

[3] vertical to the burning axis

[4] percentage of red: approx. 8%



PRK 2

PRK 4

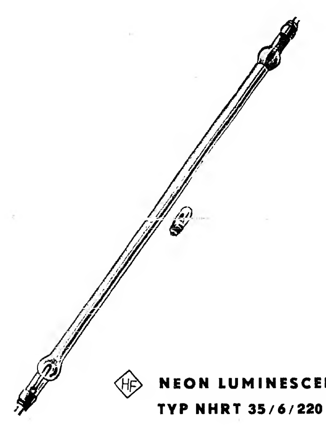
ULTRAVIOLET BURNERS, TYPES PRK 2, PRK 4

They are rod-shaped high-pressure mercury burners of quartz glass featuring a high radiation efficiency over the whole UV range (2400 to 4100 A. U.). These burners are especially well suited for prophylactic and therapeutic application.

The burners may be connected both to AC and DC. An initial choke has to be applied in case of AC-operation, whereas a series resistance is needed for DC-operation.

For special use any determined UV range may easily be filtered out by means of a suitable filter.

Type	Wattage	Feeding Voltage	Burning Voltage	Operation Current	Total Length		Weight	
	approx. watts	volts AC/DC	volts	amps.	approx. mm	inch.	approx. g	oz.
PRK 2	375	≧ 220	114...126	2,95...4	257	10$^{1}/_{8}$	75	2$^{5}/_{8}$
PRK 4	220	≧ 120	65... 75	2,85...4,05	173	6$^{7}/_{8}$	65	2$^{5}/_{16}$



NEON LUMINESCENT LAMP
TYP NHRT 35/6/220

On account of its intensive red irradiation that even penetrates fumes and fog; this high-power Neon luminescent lamp is extremely well suited to mark airports, waterways, high buildings, etc.

Hitherto, the operation of high-power Neon luminescent lamps in general required 380 volts. The NHRT 35/6/220, however, operates on a supply voltage of only 220 volts AC. Furthermore, this lamp features a long service life. Neon lamps ignite and burn reliably even at temperatures as low as $-50°$ C. The tube is about 1200 mm = $47^1/_4''$ long; it has a hard-glass bulb, and sockets at the two ends. Like all the gas-discharge lamps, the Neon luminescent lamp is connected by means of an initial choke.

Since the **Glimmzünder 2609** (glow ignitor) has exclusively been developed for our Neon luminescent lamp, there is no additional ignition coil necessary for the ignition process. The glow ignitor is approx. 85 mm = $3^5/_{16}''$ long and bears an Edison socket E 27.

Data of the Neon luminescent lamp NHRT 35/6/220:

Wattage: 350 to 440 watts

Operation Current: 6 amps.

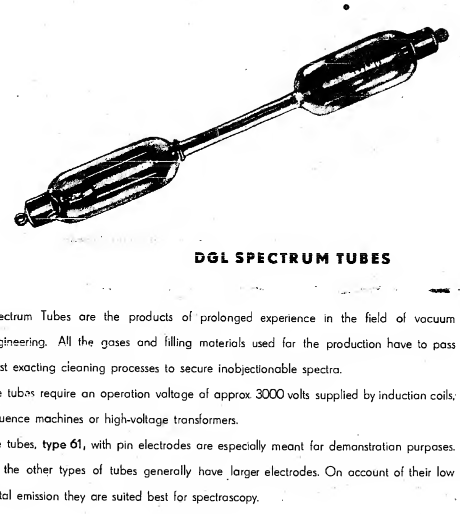
Feeding Voltage: 220 volts AC

Light Flux: 4200 lumen

Burning Voltage: 65 to 85 volts

Luminous Power: about 11 lumen per watt

Weight: about 0.41 kg = $14^1/_2$ oz.

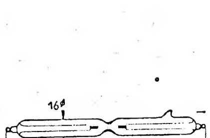


DGL SPECTRUM TUBES

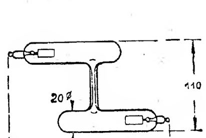
Spectrum Tubes are the products of prolonged experience in the field of vacuum engineering. All the gases and filling materials used for the production have to pass most exacting cleaning processes to secure inobjectionable spectra.

The tubes require an operation voltage of approx. 3000 volts supplied by induction coils, influence machines or high-voltage transformers.

The tubes, **type 61,** with pin electrodes are especially meant for demonstration purposes. All the other types of tubes generally have larger electrodes. On account of their low metal emission they are suited best for spectroscopy.



Type 61 (Catalogue No. 61–01 and 61–03)
Standard shape,
for lateral inspection of the luminous column



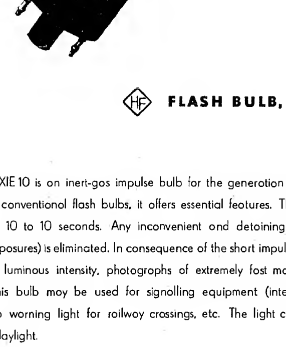
Type 63 (Catalogue No. 63–02, 63–03 and 62–13)
H-shape for twofold frontal and lateral inspection
of the luminous column

Table of the most important types in practice:

Filling Materials	Catalogue No.	Weight in grams	Weight oz.	Catalogue No.	Weight in grams	Weight oz.
H_2	61–01	20	11/16	63–02	36	1 1/4
O_2	61–01	20	11/16	63–02	36	1 1/4
N_2	61–01	20	11/16	63–02	36	1 1/4
CO_2	61–01	20	11/16			
CO	61–01	20	11/16			
NO	61–01	20	11/16	63–02	36	1 1/4
NH_3	61–01	20	11/16	63–02	36	1 1/4
H_2O	61–01	20	11/16	63–02	36	1 1/4
SO_2	61–01	20	11/16			
H_2S	61–01	20	11/16			
Hg	61–01	20	11/16			
S	61–01	20	11/16			
Ar	61–03	20	11/16	63–03	36	1 1/4
He	61–03	20	11/16	63–03	36	1 1/4
Ne	61–03	20	11/16	63–03	36	1 1/4
Kr	61–03	20	11/16	63–03	36	1 1/4
Xe	61–03	20	11/16	63–03	36	1 1/4
HeHg	63–13	36	1 1/4			
Hg *)				77–03	27	15/16
Na *)				77–03	27	15/16
K *)				77–03	27	15/16
Rb *				77–03	27	15/16
Cs *)				77–03	27	15/16

*) These tubes contain a Helium set to promote the ignition. They are suited for frontal and lateral inspection of the luminous column. Length: 125 mm; height: 75 mm (5×3").

When ordering, please state catalogue number and chemical formula of the filling material.



FLASH BULB, TYPE XIE 10

The flash bulb XIE 10 is an inert-gas impulse bulb for the generation of photo flashes. In contrast to the conventional flash bulbs, it offers essential features. This flash bulb permits exposures from 10 to 10 seconds. Any inconvenient and detaining changing of bulbs (between the exposures) is eliminated. In consequence of the short impulses of 1/5000 second and the great luminous intensity, photographs of extremely fast motions can be made. Furthermore, this bulb may be used for signalling equipment (intermittent lights), too, especially as a warning light for railway crossings, etc. The light colour is bright white similar to the daylight.

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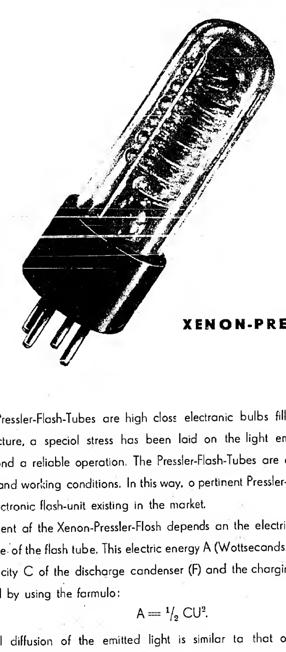
The lamp has a special socket with 3 pins, and it is approx. 145 mm (abt. $5^{3}/_{4}$″) long. The lomp may be used in combination with o pertinent set supplied by severol manufocturers.

Maximum voltage of the capacitor battery:	2.5 kv
Maximum capacity of the capacitor battery:	32 μF
Maximum power of the individual impulse:	100 Joule
Maximum permissible sequence of impulses:	6 impulses per minute
Duration of an impulse:	1/5000 second
Medium wattage for permissible sequence of impulses:	10 watts
Maximum transient value of the light flux:	$5 \cdot 10^{6}$ lumen

Weight: approx. 55 g = $1^{15}/_{16}$ oz.



XENON-PRESSLER-FLASH

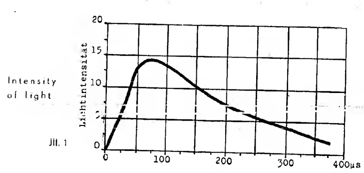
The Xenon-Pressler-Flash-Tubes are high class electronic bulbs filled with Xenon-gas. In the manufacture, a special stress has been laid on the light emitting capacity, a long service life and a reliable operation. The Pressler-Flash-Tubes are available for all grades of capacity and working conditions. In this way, a pertinent Pressler-Flash-Tube is to be had for every electronic flash-unit existing in the market.

The light extent of the Xenon-Pressler-Flash depends on the electric energy consumed for the discharge of the flash tube. This electric energy A (Wattseconds or Joules) is determined by the capacity C of the discharge condenser (F) and the charging voltage U (volts) and is calculated by using the formula:

$$A = \frac{1}{2} CU^2.$$

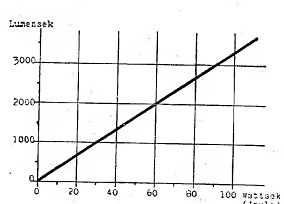
The spectral diffusion of the emitted light is similar to that of the sun-light (colour temperature about 6000° K), so that for the use of colour films daylight material should be procured.

The time of discharge, viz. the duration of the flash, amounts, according to the working conditions, to less than 0.001 of a second. This is shown by Jll. 1. and it is to be noted that for the same output, the time of discharge with a high operating voltage and a small condenser is shorter than with a small working voltage and a larger condenser.



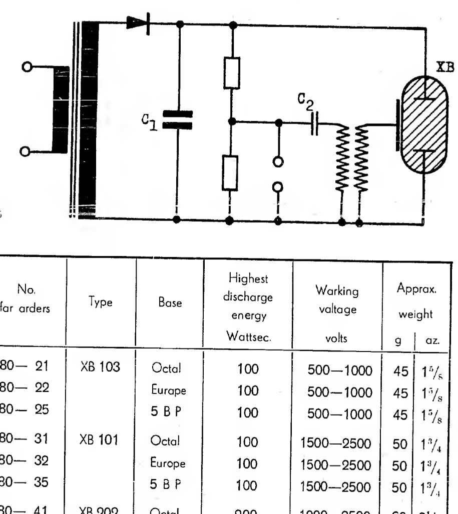
Jll. 1

The Xenon-Pressler-Flash is to be operated in all circuit connections in use for flash tubes. Our drawing on the next page (Jll. 3) gives a principle of such a connection. C_1 shows the main condenser for the operation of the flash tube, and this condenser is charged by a transformer and a rectifier. C_2 is the ignition condenser which is charged via a potentiometer formed by two resistors. By a pushlike discharge of the condenser C_2, the ignition takes place via the camera contact which is connected to the clamps, and the transformer conducts the arising voltage push to the flash tube.



Jll. 2

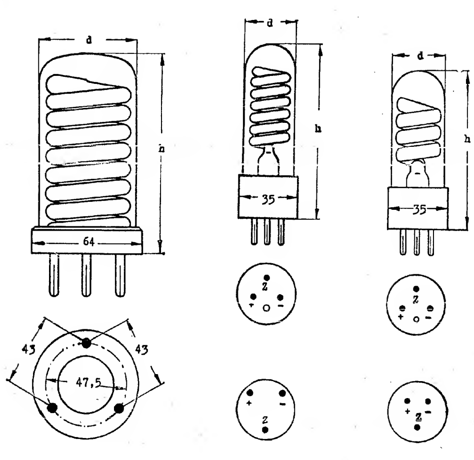
Dependence of the Lumen-seconds from the Watt-seconds of the type XB 101



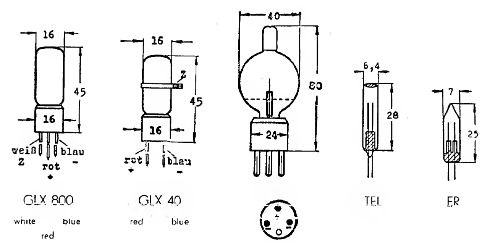
Jll. 3

No. for orders	Type	Base	Highest discharge energy Wattsec.	Working voltage volts	Approx. weight g	oz.
80— 21	XB 103	Octal	100	500—1000	45	$1^5/_8$
80— 22		Europe	100	500—1000	45	$1^5/_8$
80— 25		5 B P	100	500—1000	45	$1^5/_8$
80— 31	XB 101	Octal	100	1500—2500	50	$1^3/_4$
80— 32		Europe	100	1500—2500	50	$1^3/_4$
80— 35		5 B P	100	1500—2500	50	$1^3/_4$
80— 41	XB 202	Octal	200	1000—2500	60	$2^1/_8$
80— 42		Europe	200	1000—2500	60	$2^1/_8$
80— 45		5 B P	200	1000—2500	60	$2^1/_8$
80— 71	XB 201	Octal	200	2500—3500	60	$2^1/_8$
80— 72		Europe	200	2500—3500	60	$2^1/_8$
80— 75		5 B P	200	2500—3500	60	$2^1/_8$
80—151	XB 502	Special	500	2500—5000	190	$6^{11}/_{16}$

Measurements of the Xenon-Pressler-flash-tubes



Type XB 50 — Types XB 101, 201, 202 — Type XB 103



GLX 800 — white, blue, red
GLX 40 — red, blue
XZ 400
TEL
ER

AUXILIARY TUBES FOR ELECTRONIC FLASH IMPLEMENTS

DGL Flash Lightening Tubes are then recommended when the camero-contact must be treated especially carefully. These tubes are ovoilable in the following two designs:

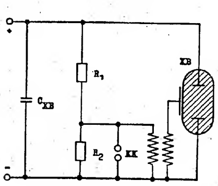
GLX 40 for a working voltage of 500 V. Ignition or flashing by meons of on external electrode. The principle of the connection circuit to be seen in Jll. 3.

GLX 800 for a working voltage of 750 V. Floshing by meons of an internol electrode. Connection circuit see Jll. 5.

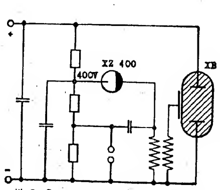
The **DGL Ignition Cell XZ 400** is used for the releose of simultaneous or common tronsmitting ond receiving units ("doughter" instruments) by the flash light of a "mother" instrument controlled by the comero. The illustrations 2, 4 ond 6 show on principle the orrangement of the ignition cell, once for implements with ordinory camera-contact flashing, on the other hond for implements equipped, for the sake of a careful treotment of the comero-contoct, with flash ignition tubes GLX 40 or GLX 800. If necessory, it is, therefore, possible to convert each flosh implement to o simultaneous (or common transmitting and receiving) unit. The working voltage of the cell is 400 V. It has neorly the same sensibility to all sides of the room, cnd its good operation is, consequently, absolutely independent from the ploce of the control instrument. The delay in the ignition of o "simultoneous" flash to thot of the control instrument is extremely smoll. It is even smaller thon 10^{-4} seconds, and thus ensures thot in the moment of the snap-shot both implements ore practicolly floshing up simultoneously.

The **DGL Glow Tubes for being built-in, Types TEL and ER,** indicate the state of charge of the flash-condenser. They are preferably built into the hondle of the control implement. Delivery for 110 and 220 V working voltage. Their glow voltage is obout 90 or 150 V, and the flash voltoge omounts to 100 or 160 V. When choosing the series resistances, it should be made o point that the overoge lood of these glow (discharge) tubes must not exceed 0.25 mA. In the connection, os per ill. 7, the glow tube lights periodicolly up d u r i n g the charging of the flash condenser; ill. 8 shows the lighting up of the glow tube a f t e r the chorge of the flash condenser.

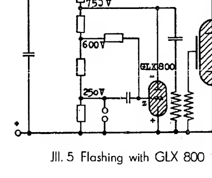
No for orders	Type	Denomination	Working voltage volts
34 – 51	GLX 40	Flash Lightening Tube	500
34 – 41	GLX 800	Flash Lightening Tube	750
90 – 389	XZ 400	Ignition Cell	400
41 – 14	TEL 110	Glow Tube for being built-in	110
41 – 04	TEL 220	id.	220
13 – 81	ER 110	id.	110
13 – 82	ER 220	id.	220



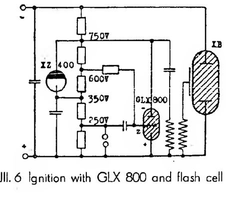
Jll. 1 Contoct floshing



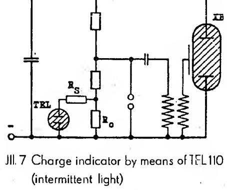
Jll. 2 Contoct ignition with flash cell



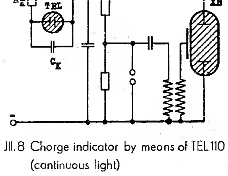
Jll. 3 Flashing with GLX 40



Jll. 4 Ignition with GLX 40 and flash cell

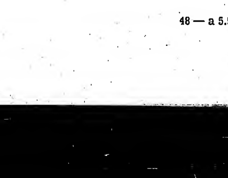


Jll. 5 Flashing with GLX 800



Jll. 6 Ignition with GLX 800 and flash cell

Jll. 7 Charge indicator by means of TEL 110 (intermittent light)



Jll. 8 Charge indicator by means of TEL 110 (continuous light)

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ELECTRONIC FLASH TUBES

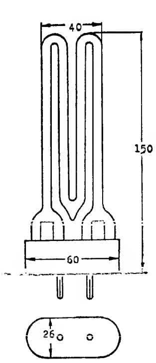
Inert gas-Xenon-Pressler-Flash

Special types without incorporated ignition electrodes

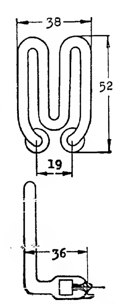
The possibility of a universal use of the Xenon-Pressler-Flash has in many cases to answer special optical conditions. To meet these various requirements, a number of special types has been designed. A selection of them is given below. We are quite in a position to vary the length and the diameter of the tubes or, if required, to produce further special shapes.

Selection of special tubes without incorporated ignition electrodes:

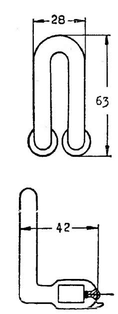
No. for orders	Denomination	Base	Max. Discharge energy in watts/sec.	Working voltage volts
80 – 11	Lyra XB 102	Special	200	1000 – 2500
00 – G18	Small Lyra	without	80	500 – 1500
00 – G16	U-Flash	without	75	500 – 1000
00 – G33	Flash tube	without	100	1000 – 2000
00 – G69	Spiral flash	without	400	4000 – 5000
00 – G43	Ring flash	without	200	1500
80 – 60	Stroboscope XS 2000	Special	(15 watts)	500 – 1000
00 – G63	Cylinder	without	80	500 – 1000
00 – G39	Spiral	without	50	1500
00 – G19	U-flash	without	50	500 – 1000
00 – G34	Point flash	without	25	300 – 500



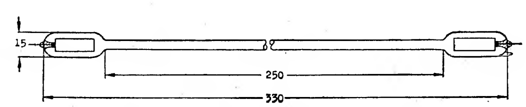
Lyra XB 102



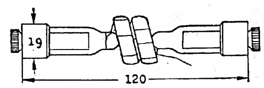
Small Lyra 00 – 18



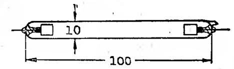
U-Flash 00 – G16



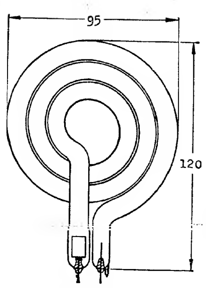
Flash tube 00 – G 33



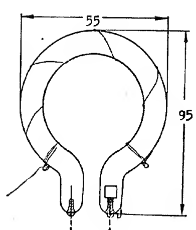
Stroboscope XS 200



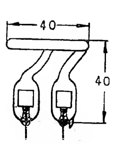
Cylinder 00 – 63

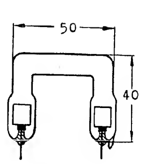


Spiral flash 00 – 69

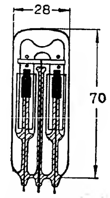


Ring flash 00 – G 43



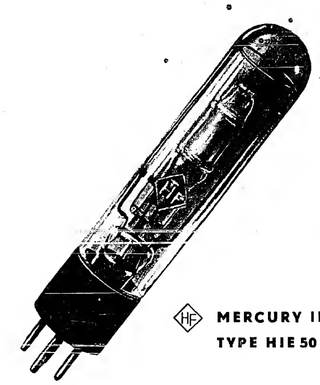


U-flash 00 – G 19



Point flash
00 – G 34

Spiral 00 – G 39



MERCURY IMPULSE TUBE TYPE HIE 50

The mercury impulse tube HIE 50 is especially meant for the incorporation in stroboscopes. For a capacitor voltage of maximum 800 volts, the sequence of impulses permitted amounts to 800 impulses per second. Besides, the tube is built for continuous 220-volt AC operation. In this case, an initial choke is required.

Inter alia, stroboscopes are used for the measuring of rotating speeds and for the examination of rapid and periodically passing mechanical processes.

The tube has a four-terminal "Europa" socket and is approx. 160 mm ($6^5/_{16}$") long. The mercury impulse tube HIE 50 (in permanent operation) yields the following data:

Wattage: approx. 50 watts
Feeding voltage: $\geqq$ 220 volts AC
Burning voltage: approx. 40 volts
Service current: approx. 1.5 amps.
Light flux: approx. 700 lumen
Luminous power: approx. 14 lumen per watt

Weight: approx. 55 g = $1^{15}/_{16}$ oz

RFT LOW-VOLTAGE FLUORESCENT LAMPS BGW

Lamp-Type No.	Electrical Data		Light Flux	Dimensions (Maximum Sizes)				Remarks
				diam.		Length		
	watts	mAmp.	lm	mm	inch.	mm	inch.	
66.9266/00 66.9267/00 16.9268/00 66.9269/00	14		600			470	18 1/2	
66.9326/00 66.9327/00 66.9328/00 66.9329/00	20	290	750	35	1 3/8	720	28 3/8	
66.9376/00 66.9377/00 66.9378/00 66.9379/00	25		1150			970	38 1/4	
66.9376/01 66.9377/01 66.9378/01 66.9379/01						370	14 5/8	U-shape
66.9406/00 66.9407/00 66.9408/00 66.9409/00	40	410	1800	38	1 1/2	1200	44	
Glaw ignitars for the types mentianed above minus sacket in tubular shape (12 ∅, length 22_{-2})								

The 6th digit of the lamp number indicates the colour of the light: 6 = warm-white, 7 = daylight-white, 8 = yellowish-white, 9 = yellowish-white warm-tone

Special types upon inquiry.

When ordering, please state lamp type number

Vacuum tube lamps are low-pressure gas-discharge lamps whose inside glass surface has been covered with fluorescent substances. Under certain working conditions (i. e., low pressure and low current) approx. 50 percent of the applied electrical power can be converted into UV-radiation. This ultraviolet radiation excites the fluorescent substance on the inside surface of the tubes that, depending on its composition, radiates visible light of all wave lengths. The tubes are filled with an inert gas of some millimeters filling pressure, and a small quantity of mercury. Each tube has four connections. The elongated shape of the vacuum tube results from the fact that the filament efficiency per centimeter length of the glass tube must not exceed approx. 0.5 watts. An U-shaped vacuum tube lamp has been developed to be used in lamps of reduced construction length (see picture).

Advantages of vacuum tube or fluorescent lamps

Economical operation

In comparison with incandescent bulbs, vacuum tube lamps of the same flux feature a filament consumption reduced by approx. 75 percent. The application of vacuum tubes not only reduces considerably the expenses for illumination purposes but also results in essential savings of electric power.

Service life

Under normal service conditions, vacuum tube lamps have a service life of 300 to 400 percent of that of incandescent bulbs. They will probably last from 3500 to 4000 hours considering a normal switching frequency of 3 to 4 hours per operation. In case of reduced switching frequency, (e. g., permanent service in workshops, offices, etc.), the service life increases considerably. The service life will even be longer than that of incandescent bulbs when they are switched in $^1/_2$- to 1-hour operation intervals.

Despite the higher initial price of the vacuum tubes, the annual total illumination costs (including current consumption and bulb replacement costs) will be lower than the costs with incandescent bulb operation. (This calculation bases on the assumption that the vacuum tubes are used more than 100 hours annually, i. e., more than $^1/_4$ hour per day, and that the price of the current is not lower than 6 Pfennigs per kilowatt hour incl. meter rent.)

Besides these economic advantages, fluorescent lamps feature considerable advantages as to light engineering in comparison with incandescent bulbs. These advantages are:

Anti-dazzle

The density of light (the factor for dazzling) of the fluorescent lamp is below that of a candle. The density of light of the incandescent bulb is about 1000 times higher. To prevent disturbed vision by the excessive dazzling of incandescent bulbs it is necessary to use diffusing lamps or lamp shades swallowing a considerable quantity of the light. When using fluorescent lamps, light-dispersing materials can be used, too, without any noticeable loss of light in case of especially high requirements as to anti-dazzle.

Shadeless operation

The size of the fluorescent lamps permits nearly shadeless illumination. The uniform illumination of the vision space thus achieved results in improved vison due to the missing contrast.

Choice of the colour

Fluorescent lamps are available in these colours:

- daylight white
- warm white
- yellow white
- warm-tone.

Since the type HNT has about the same colour distribution as normal daylight (the light of the overcast sky), fluorescent lamps of the type HNT are exceptionally well suited as additional illumination to the daylight, because any twilight phenomena are avoided. They find also application whenever it is required to recognize precisely the natural colours. (In this case, however, it is to be noted that the human eye is used to higher luminous intensities for the colour of the daylight than for the colour of artificial light sources; therefore, it is necessary to supply a sufficient luminous intensity with HNT fluorescent lamps to eliminate the impression of a "fallow" light.)

Reduced development of heat

Fluorescent lamps, in contrast to incandescent lamps are not developing any disturbing heat while in operation. Thus, fluorescent lamps can be placed on the working table close to the workpiece to be processed.

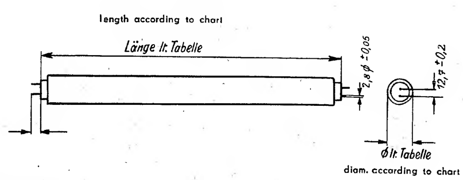
Jlluminotive aspects

Fluorescent lamps offer entirely new aspects of illumination to architects and interior decorators. It is also very simple and economical to accomplish indirect interior illumination by means of fluorescent lamps.
Fluorescent lamps do not emit any harmful irradiation. Though some short-wave ultraviolet irradiation is produced, the tubular glass wall absorbs it almost completely. The ultraviolet portion of the lamp's radiation is considerably smaller than that of the sunlight.
The operation of fluorescent lamps by means of switches or wall sockets is exactly as simple and their replacement as convenient as that of incandescent bulbs.

Technical data

The luminous efficiency of fluorescent lamps is approx. four times as large as the luminous efficiency of an incandescent bulb of the same filament efficiency. The power consumption incl. preset amounts to approx. $^1/_3$ of the power consumption of an incandescent bulb of the same efficiency.

Diagram of the lamp, indicating sockets and socket pins

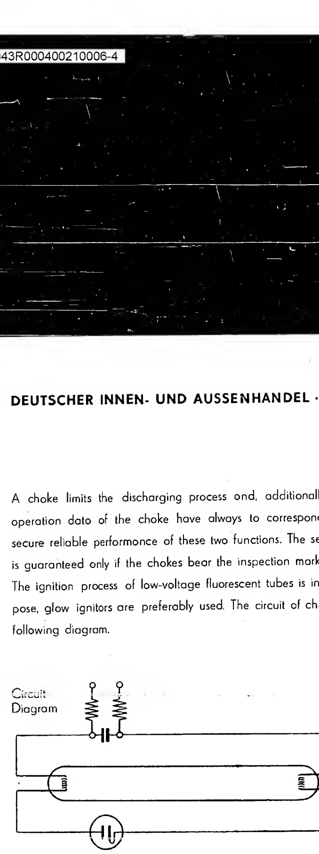


Accessories

Due to the decreasing characteristic of the fluorescent lamps, all types have to be operated with a preset device.
Any direct connection of the fluorescent lamp with the power main will destroy the lamp.

A choke limits the discharging process and, additionally, it initiates the ignition. The operation data of the choke have always to correspond with the tube in question to secure reliable performance of these two functions. The service life of the fluorescent tube is guaranteed only if the chokes bear the inspection mark of the supplier BGW.
The ignition process of low-voltage fluorescent tubes is initiated by starters. For this purpose, glow ignitors are preferably used. The circuit of choke and starter is shown in the following diagram.

Circuit Diagram



D = choke (symmetric arrangement)
Z = ignitor
K_1 = compensation capacitor
K_2 = interference suppressor
L = fluorescent tube
N = supply voltage 220 volts AC

Accessories

Type of Tube	Choke Symbol	Capacity of Compensation Capacitor	Capacity of the Interference Suppressor
HN 50	O		
80	P		10 000 pF = 10 nF
120	Q	4 μF	
202	P	4.5 μF	

Service Conditions of fluorescent tubes

Supply voltage

At present fluorescent tubes are made only for 220 volt AC. The voltage variations are not to exceed ± 10 percent. Application to voltages below 190 volts will reduce the service life of fluorescent. The luminous efficiency of fluorescent tubes is not so much effected by voltage variations as is the luminous efficiency of incandescent bulbs. In fact, their efficiency fluctuations amount only to about 1/4 of those of incandescent lamps.

Dependency on temperature

Fluorescent lamps have their highest luminous efficiency at environment temperatures ranging from 15 to 30° C. The luminous efficiency decreases considerably at temperatures below 8° C. Ignition in case of lower temperatures may be achieved by the use of cold-resistant lamps. (For intended outdoor use with fixed luminous efficiency, fluorescent tubes must be protected by encasings.)

Waviness of the luminous efficiency

As a consequence of the gas discharge free from inertia, the luminous efficiency fluctuates in the rhythm of the supply voltage. In case of the illumination of motions, the well-known stroboscopic effect may occur. Artificial circuits such as three-phase or dual operation may reduce this stroboscopic effect.

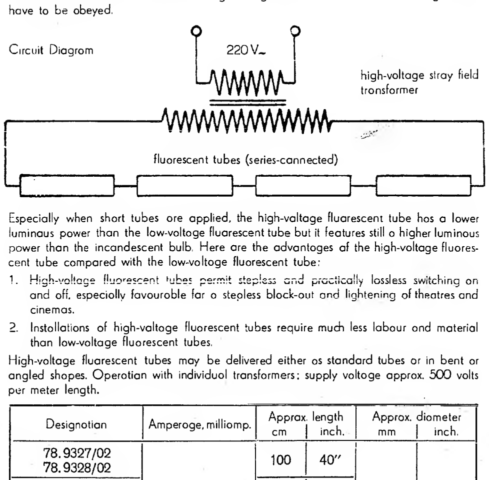
Troubles during operation

The description about installation and operation of low-voltage fluorescent tubes (furnished upon request) aids in the tracing of faults.

BGW High-Voltage Fluorescent Lamps

are connected by means of an initial stray field transformer according to diagram below. Depending on the transformer voltage, a number of fluorescent lamps may be series-connected. As to the installation of high-voltage fluorescent tubes, the valid regulations have to be obeyed.

Circuit Diagram



Especially when short tubes are applied, the high-voltage fluorescent tube has a lower luminous power than the low-voltage fluorescent tube but it features still a higher luminous power than the incandescent bulb. Here are the advantages of the high-voltage fluorescent tube compared with the low-voltage fluorescent tube:

1. High-voltage fluorescent tubes permit stepless and practically lossless switching on and off, especially favourable for a stepless block-out and lightening of theatres and cinemas.
2. Installations of high-voltage fluorescent tubes require much less labour and material than low-voltage fluorescent tubes.

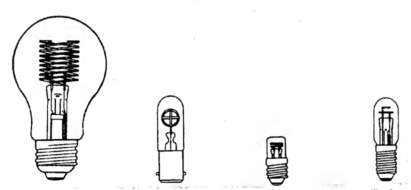
High-voltage fluorescent tubes may be delivered either as standard tubes or in bent or angled shapes. Operation with individual transformers; supply voltage approx. 500 volts per meter length.

Designation	Amperage, milliamp.	Approx. length cm	Approx. length inch.	Approx. diameter mm	Approx. diameter inch.
78.9327/02 78.9328/02	80	100	40″	22	7/8
78.9327/04 78.9328/04		150	60″		
78.9327/06 78.9328/06		200	80″		

The 6th digit of the lamp type number indicates the colour of the light: 7 = bluish-white, 8 = yellowish-white. Additional colours in special production. Production of tubes with angled electrodes and in quarter-circle and semicircle sections upon inquiry.

BGW high-voltage fluorescent tubes for advertising purposes are made of clear glass red and blue, of filter glass green and blue, and with fluorescent material in 8 different colours.

Dimensions and types upon inquiry.



Ill. 103 Ill. 104 Ill. 105 Ill. 106

RFT GLOW LAMPS BGW

with incorporated resistors

Due to their low consumption of current, BGW glow lamps may advantageously be used for permanent operation if their luminous efficiency is sufficient. The resistor incorporated in the socket permits a direct connection of the BGW glow lamp to DC and AC networks. Since the total dimensions can be kept very small, they may well be used as voltage indicators in plants and appliances of all kind, in calling equipment and as signalling lamps on switchboards. Furthermore, they may be employed for bedside lamps in bedrooms and sickrooms, for emergency illumination, etc.

In contrast to incandescent bulbs whose service life and luminous efficiency is very much effected by any change of the voltage, glow lamps may be used within a certain range of voltage. Therefore, BGW has classified the glow lamps in voltage groups (see chart next page). To secure a perfect ignition, the lower limitation of every group has been chosen so that it lies clearly above the highest ignition voltage possible with DC operation. The resistor incorporated in the socket is rated large enough to secure the necessary service life and luminous efficiency for practical operation.

In BGW signal lamps and midget-size glow lamps, the junction electrode is connected with the bottom contact of the socket whereas the ring electrode is connected with the rim of the socket. In case of DC operation, maximum reliability of ignition is achieved when the bottom contact is connected with the negative pole.

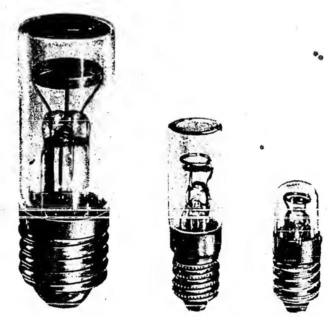
A series resistance is required for the operation of the BGW voltage-tracer glow lamps since any direct connection to the power line would result in the destruction of the lamps on account of excessive input, or the fuses are blown.

Lamp Type No.	Electrical Data volts	milli amps.	watts	Size (max. size) ⌀ mm/inch	Length mm/inch	Socket	Picture No.
BK Glow Lamps							
81.1000/00	100...115		1—2	60 2[illegible]	103–5 4 1/8–13/64	E 27/25	103
81.1400/00	115...130						
81.1700/00	210...240		2—3				
Signal Glow Lamps, Size 3							
81.3000/00	100...115		0,25	16 5/8	55–3 2 3/16–1/8	E 14/22	104
81.3400/00	115...130						
81.3700/00	210...230		0,5				
Midget-Size Glow Lamps							
81.7000/00	110...130		0,075	12 15/32	30–2 1 [illegible]/16–1/16	E 14/17 × 12	105
81.7200/00	130...160						
81.7300/00	200...260						
Voltage-Tracer Glow Lamps without built-in Resistor							
81.2150/00	110...750	1		16 5/8	56—3 2 3/16–1/8	B 15s/19	106

Special designs supplied upon inquiry.

When ordering, please state number of lamp type.

The voltage-tracer glow lamp is manufactured positively without series resistance since a resistor is incorporated into the handle of the voltage tracer. The +-shaped electrode is connected with the bottom contact

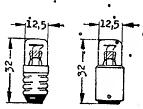


DGL SIGNAL GLOW DISCHARGE TUBES

All the DGL-Glow Discharge Tubes are for use on DC and AC voltage. The tubes with incorporated resistances can only be used for the indicated working voltages. For higher tensions on additional and special series resistance – size as per the following table – is necessary. The large-faced sizes are printed on the bases of the tubes.

As to the Glow Discharge Tubes without incorporated resistors, a direct connection to the circuit should be avoided. This table gives the necessary series resistances in kOhms.

Type	110 V	150 V	220 V	250 V	380 V	500 V	1000 V
MR 110	50	100	200	250	450	600	1300
MR 220	–	–	100	150	350	500	1200
FR 110	25	50	100	120	200	300	600
FR 220	–	–	50	70	150	250	600
GRM 110	4	10	20	30	50	70	150
GRM 220	–		15	20	40	60	150



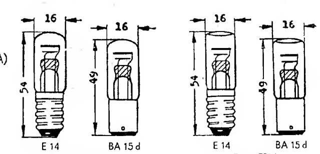
Micron Tubes, Type MR

(Current Consumption 0.7 mA)

No. for orders	Type	Base	Resistor	Working voltage volts	Approx. weight g	oz.
14 – 01	MR 110	without	without	as per table		
14 – 02	MR 110	E 14	built-in	100 – 115		
14 – 03	MR 110	E 14	without	as per table		
14 – 04	MR 110	BA 15d	built-in	100 – 115		
14 – 05	MR 110	BA 15d	without	as per table	7	1/4
14 – 11	MR 220	without	without	as per table		
14 – 12	MR 220	E 14	built-in	200 – 230		
14 – 13	MR 220	E 14	without	as per table		
14 – 14	MR 220	BA 15d	built-in	200 – 230		
14 – 15	MR 220	BA 15d	without	as per table		

Front Alarm Tubes, Types FRB and FRM

(Current Consumption 1,5 mA)



Type FRB (without sintered lens)

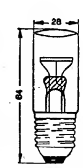
Type FRM (with sintered lens)

No. for orders	Type	Base	Resistor	Working voltage	Appr. weight g	oz.
12 – 02	FRB 110	E 14	built-in	100 – 120		
12 – 03	FRB 110	E 14	without	as per table		
12 – 04	FRB 110	BA 15d	built-in	100 – 120		
12 – 05	FRB 110	BA 15d	without	as per table		
12 – 12	FRB 220	E 14	built-in	200 – 250		
12 – 13	FRB 220	E 14	without	as per table		
12 – 14	FRB 220	BA 15d	built-in	200 – 230		
12 – 15	FRB 220	BA 15d	without	as per table	10	3/8
11 – 02	FRM 110	E 14	built-in	100 – 120		
11 – 03	FRM 110	E 14	without	as per table		
11 – 04	FRM 110	BA 15d	built-in	100 – 120		
11 – 05	FRM 110	BA 15d	without	as per table		
11 – 12	FRM 220	E 14	built-in	200 – 230		
11 – 13	FRM 220	E 14	without	as per table		
11 – 14	FRM 220	BA 15d	built-in	200 – 230		
11 – 15	FRM 220	BA 15d	without	as per table		

Large Alarm Tubes, Type GRM

(Current Consumption 6 mA)

No. for orders	Type	Base	Resistance	Working voltage	Approx. weight g	oz.
10 – 02	GRM 110	E 27	built-in	100 – 115		
10 – 03	GRM 110	E 27	without	as per table	35	$1^3/_{16}$
10 – 12	GRM 220	E 27	built-in	200 – 230		
10 – 13	GRM 220	E 27	without	as per table		



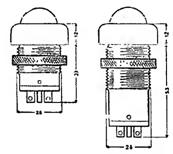
Type GRM

DGL Sockets, to be incorporated

made of black plastic material, for one-hole fitting

These sockets of new style are provided with screwed-on bow windows preventing the entrance of dust and moisture and on unqualified removal of the lamp.

The lamp sockets are available with calotte glasses of various colours, e. g., clear, red, yellow and opal. Orders for these DGL-sockets without specification will be executed with clear glass calotte.



Type MR Type FRB/FRM

No. for orders	For Type	Approx. weight	
		g	oz.
49 – 22	MR/E 14	30	$1\,^{1}/_{16}$
49 – 22/L*)	MR/E 14	30	$1\,^{1}/_{16}$
49 – 02	FRB/FRM/E 14	35	$1\,^{3}/_{16}$
49 – 02/L*)	FRB/FRM/E 14	35	$1\,^{3}/_{16}$

*) With built-in extinguishing arrangement

The above mentioned sockets are available, if desired, with incorporated extinguishing arrangement, so to avoid capacitive inductions from neighbouring AC lines and an undesired lighting up at open circuit.

INSTALLATION GLOW TUBES for small hold

No. for orders	Type	Nominal voltage Volts	Base
Installation Glow Tube, Type ER for lateral view / Current consumption 0.25 mA			
13 – 81	ER 110	110	without
13 – 82	ER 220	220	without
13 – 181	ER 110/S	110	BA 7s
13 – 182	ER 220/S	220	BA 7s
49 – 13	Swan socket for ER/S		
Installation Glow Tube, Type TEL for front view, with lens / Current consumption 0.25 mA			
41 – 14	TEL 110	110	without
41 – 04	TEL 220	220	without
41 – 214	TEL 110/F	110	Screw socket
41 – 204	TEL 220/F	220	Screw socket
41 – 114	TEL 110/S	110	Plug base
41 – 104	TEL 220/S	220	Plug base
49 – 50	Socket for TEL/S for one-hole fitting, with screwed-on calotte glass		
Installation Glow Tube, Type BS for lateral view / Current consumption 0.25 mA			
35 – 01	BS 40	110	Metal caps
35 – 23	BS 220	220	Metal caps
35 – 02	BS 40	110	without
35 – 24	BS 220	220	without
Universal Glow Tube, Type UR, and Pole Testing Tube, Type PR for lateral view / Current consumption 0.5 mA			
35 – 61	UR 110	110	Metal caps
35 – 71	UR 220	220	Metal caps
35 – 62	PR 125	110	Metal caps
35 – 72	PR 220	220	Metal caps

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The **Installation Glow Tubes** of the last page are in the first place used for voltage indication in electric devices. They are, furthermore, incorporated in voltage testing instruments (so-called glow voltage indicators). These tubes require very small space only. Type ER in the design with loose wire ends is easily to be solded in an existing circuit; the special shape S is provided with the bayonet base BA 7s.

Type TEL is available in three designs: with loose wire ends, with plug-base and with a screw socket into which the tube is firmly puttied.

Type TEL/S with plug base for incorporation is used when the interchangeability of the installation glow tube is wanted.

The types BS, UR and PR are at both ends provided with metal caps, but on request, they are also available with loose wire ends.

All tubes are fit for DC and for AC. The tubes with a nominal voltage of 110 volts may be used for voltages from about 90 volts upwards, and those with a nominal voltage of 220 volts for a tension from about 160 volts upwards. The ignition voltage is always inferior than the nominal voltage.

Please note that all the glow tubes of our lists have no incorporated resistance and that, when connecting the tubes in circuit, a special resistor must be provided. Sizes according to the following table:

Type	Series resistances required, in kOhms						
	110 V	150 V	220 V	250 V	380 V	500 V	1000 V
ER 110	150	350	700	1000	1500	2000	5000
ER 220	—	—	300	500	1000	1500	4000
TEL 110	100	250	500	700	1000	1500	2000
TEL 220	—	—	200	400	800	1200	3000
BS 40	150	350	700	1000	1500	2000	5000
BS 220	—	—	300	500	1000	1500	4000
UR 110	100	250	500	750	1000	1500	3000
UR 220	—	—	200	500	800	1200	3000
PR 125	50	150	300	400	600	800	2000
PR 220	—	—	100	250	400	600	1500

SPECIAL TUBES FOR VOLTAGE INDICATION

especially fit for high voltages and high frequencies

The special tubes decribed in these 2 pages are without exception tubes in which the positive column is lightening up. Their purpose is to indicate the presence of tensions, especially of high voltages or high frequencies, or to produce light spots for stroboscopic purposes.

The tubes with external electrodes are for AC only. The tubes with internal electrodes may be used for AC in all frequencies, as well as for DC impulses.

High Voltage Tubes, Types HSR 210 and HSR 160

By one pole they are connected to the conductor or to the collecting bar. Both types are available with the fixtures of our drawings or with the base E 14. The tubes are lightening up when the line is live.

High Frequency Tubes, Types HK 100, 150 and 250

for indicating high frequency oscillations in valve generators, in induction instruments, spark gaps etc. These tubes are specially fit for transmitters of the short wave series.

Voltage Indicating Tubes, Type HR 00

for high frequency and indication of alternating voltages, for low tensions (ignition voltages of about 250 V).

Voltage Indicating Tubes, Type KG 50

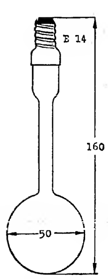
with ball-shaped external electrodes, for the determination of voltage fields.

Special Tubes, as per Type Schering SS 27

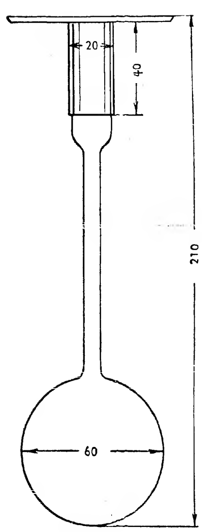
to state the voltage distribution at insulator surfaces (See the German paper "Elektrotechnische Zeitschrift" 1935, H. 4, page 75).

Small Tubes for High Frequency Indication, Type LR

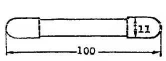
to be fitted in control and test instruments (spark plug testers, "Zipp" high voltage indicators etc.) Available in lengths of 20 to 50 mm ($^{25}/_{32}$ to 2 inch.), diameters 4 to 8 mm ($^{5}/_{32}$ to $^{5}/_{16}$ inch.).



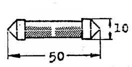
HSR 160



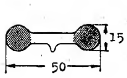
HSR 210



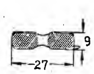
HK 100



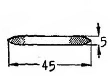
HR 100



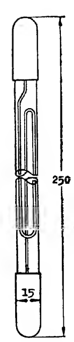
KG 50



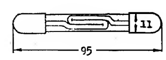
SS 27



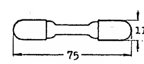
LR



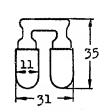
HSR 250



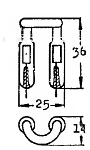
ZR 95



KA 75 / KI 75



UA 33
UI 33



UI 33/A

High Voltage Tubes, Type HSR 250

As a rule, these tubes are with two poles connected to the voltage. The capillary loop is lightening up when the line is live. In case the tubes are by one pole connected to an alternating voltage, the free pole should, so to increase the capacity, preferably be provided with a metal ring or a metal plate.

Spark Plug Testing Tubes, Type ZR 95

The tube glows dimly when the spark plug is working correctly. If there is an interference, the tube lightens brightly, and at a short-circuit of the spark plug it remains dark.

Voltage Indicating Tubes, Type KA 75

with a capillary to increase the density of the light, suitable as indicator tube.

Voltage Indicating Tubes, Type KI 75

Same tube as before, but with internal electrodes. It is specially used as stroboscope and indicator tube, also fit as incorporation tube for high voltage testing bars.

Voltage Indicating Tubes, Type UA 33

same as KA 75, but bent to U-shape.

Voltage Indicating Tubes, Type UI 33

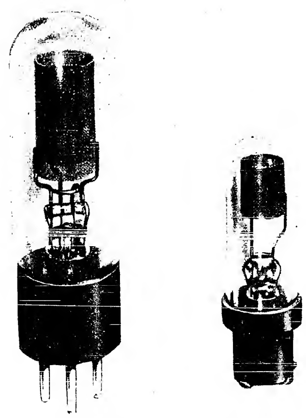
same as KI 75, but bent to U-shape.

Special Tube UI 33/A

suitable as timer in echo sounding devices.

No. for orders	Type	Ignition voltage abt. eff. kV	Working voltage abt. eff. kV	Electrode	Current or frequency
70 – 21	HSR 210	6	10 – 100	external	LF
70 – 11	HSR 160	4	5 – 20	external	LF
71 – 10	HK 100	1	1 – 5	external	HF
71 – 15	HK 150	1	1 – 10	external	HF
71 – 25	HK 250	2	1 – 15	external	HF
71 – 00	HR 00	0,250	0,3 – 0,5	external	HF, LF
74 – 50	KG 50	0,5	0,5 – 2	external	LF
74 – 27	SS 27	0,2	–	internal	LF
73 – 455	LR 45 × 5	0,2 – 0,4	0,2 – 2	external	HF
76 – 25	HSR 250	4	5 – 15	external	LF
76 – 95	ZR 95	–	–	external	HF
75 – 01	KA 75	0,8	ab 1	external	LF, HF
75 – 02	KI 75 *)	0,5	ab 0,5	internal	LF, HF, DC
75 – 11	UA 33	0,8	ab 1	external	LF, HF
75 – 12	UI 33 *)	0,5	ab 0,5	internal	LF, HF, DC
75 – 13	UI 33/A*)	0,5	ab 0,5	internal	LF, HF, DC

*) These tubes are for impulse load only. At continuous working, a current limiting resistor must be inserted (1 mA).



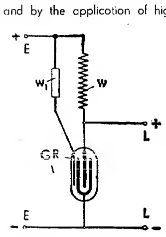
DGL SMOOTHING TUBES

Glättung

The smoothing tubes are the simplest technical voltage stabilizers since they have neither mechanically operated parts nor do they require complex circuits. They are applied to smooth both fluctuations of the network voltage and such voltage variations occurring in electric devices with changing loads. Smoothing tubes automatically stabilize voltages even in cases where controlling by means of instruments and manual readjustment had been necessary until now. Smoothing tubes have their special field of application in the connection of photocell circuit arrangements, measuring amplifiers, tube testing devices and wireless sets.

Note: smoothing tubes have no incorporated resistors and thus must not be applied to voltages directly.

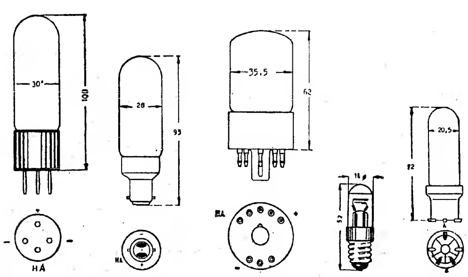
The basic arrangement of the smoothing tube with auxiliary electrode is shown by picture No. 1. The operation voltage is applied to the terminals E; the smoothed voltage is drawn at the terminals L. The series resistance W is of special importance for the stabilizing effect, since the smoothing performance is improved by the increased resistance value and by the application of higher operation voltages. The auxiliary anode is connected to the operational voltage source via the highly resistive resistance W_1 of approx. 1 megohm. The auxiliary anode facilitates the ignition of the glow column whenever the device is switched on or after high loads.



Picture No. 1. Block diagram of a smoothing tube with auxiliary anode

If the drain of current should exceed the maximum values stated in the table, two smoothing tubes have to be applied in parallel connection.

In case the tubes with auxiliary anodes are used in circuits not requiring any auxiliary anode, this electrode either may be left unapplied or it may be connected with the main electrode.



shape A shape M shape P shape F shape Z

List of Available Smoothing Tubes

Catalogue No.	Type	Max. Voltage approx. volts	Max. Amperage (i_v) milliamps.	Minimum Operation Voltage volts	Closed Circuit Current (i_r) mA	Shape	Auxiliary Electrode	Weight g	Weight oz.
20 – 12	GR 150/DA	150	50	200	10	A	with	45	$1^5/_8$
22 – 12	GR 150/DM	150	60	200	10	M	with	20	$^{11}/_{16}$
24 – 22	GR 145/DP	150	60	200	10	P	with	40	$^{19}/_{16}$
26 – 12	GR 150/DK	150	15	200	2	K	with	10	$^3/_8$
27 – 11	GR 140/F	140	1	200	0,1	F	minus	10	$^3/_8$
20 – 42	GR 100/DA	100	60	140	10	A	with	45	$1^5/_8$
22 – 42	GR 100/DM	100	60	140	5	M	with	20	$^{11}/_{16}$
25 – 45	GR 100/Z	100	15	140	3	Z	minus	15	$^9/_{16}$
25 – 14	GR 150/DZ	150	15	200	3	Z	with	15	$^9/_{16}$
27 – 51	GR 80/F	80	6	110	0,1	F	minus	10	$^3/_8$

The series resistance W for smoothing tubes is computed according to this formula:

$$W = \frac{U_b - U_e}{i} \text{ where}$$

U_b = operation voltage $\quad i = i_v + i_r$

U_e = max. voltage to be drawn $\quad i_v$ = amperage of the consumer

i_r = closed circuit current (transverse current)

Intentionally, the values of the closed circuit current of the individual smoothing tubes have been indicated relatively high since at any rate a high closed circuit current offers always increased security against those fluctuations in operation resulting in a decreased current of the tube. In cases with limited power supply, it is possible to remain below the indicated closed circuit current. In these cases, however, it is recommended to operate always with the auxiliary anode. To achieve a perfect smoothing effect, it is necessary to employ an operation voltage of at least 35 percent higher than the voltage to be drawn.

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High Voltage Smoothing

a) for 1 milliamp.

Combined glow-voltage stabilizer incorporated in plastic block. These stabilizers are available for output voltages of approx. 300, 375, 450, 525, 600, 675, 750, 825 and 900 volts. Max. current output 1 milliamp. These stabilizers are suited for devices with low current consumption, e. g., cathode-ray oscillographs, radiation counters, etc.

Catalogue No.	Type	Appr. weight g	Appr. weight oz.	Catalogue No.	Type	Appr. weight g	Appr. weight oz.
27—640	GRS 80/F/300	80	$2\frac{13}{16}$	27—614	GRS 140/F/675	105	$3\frac{3}{4}$
27—650	GRS 80/F/375	85	3	27—605	GRS 140/F/750	110	$3\frac{7}{8}$
27—660	GRS 80/F/450	90	$3\frac{3}{16}$	27—615	GRS 140/F/825	115	$4\frac{1}{16}$
27—651	GRS 80/F/525	95	$3\frac{3}{8}$	27—606	GRS 140/F/900	120	$4\frac{1}{4}$
27—604	GRS 140/F/600	100	$3\frac{9}{16}$				

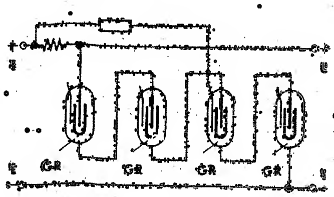
b) for 1 to [illegible] milliamps.

If it is required to keep higher voltages constant, this can be achieved in the simplest way by series-connecting of our listed standard types. The output voltage corresponds to the sum of the burning voltage of the individual tubes in series connection.

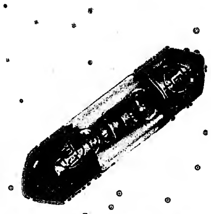
The tubes are selected according to the output current and final voltage desired. For the calculation of operation voltage and series resistance, please note the directions above.

In order to facilitate the ignition, an auxiliary ignition circuit is recommended, and it is favourable to connect the auxiliary ignition resistance with one of the centre tubes of the series connection. (Picture No. 2).

Picture No. 2.
Series connection
of four
smoothing tubes



[illegible]



DGL INDUCTION LAMPS

Induction lamps are designed to preserve relay contacts, to prevent the burning at the breaking points in case of arcing and to perform extended suppression of interferences (broadcast reception) when electric circuits are disconnected.

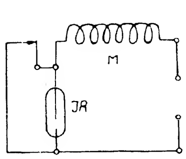
Induction lamps are especially used for the protection of sensitive relay contacts, for interrupters, bells and inductively loaded circuits, and for interrupters and switches in transformer circuits.

The induction lamps are suited for direct and alternating current. It is necessary to adopt them to the operation voltage. When ordering, please state kind of current and voltage.

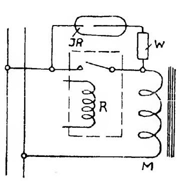
The lamp has to be parallel-connected to the contact in question. In case the circuit of the interrupter contact has only one coil of high inductivity, the glow lamp may also be parallel-connected to this coil.

A 500- to 1000-ohm resistance has to be series-connected to the glow lamp in D. C. circuits with operation voltages of 60 volts and higher.

Induction lamps are well suited for electric circuits with a wattage not exceeding 50 watts.

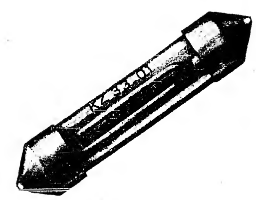


Picture No. 1
Induction lamp for interference suppression and contact preservation of an electric bell

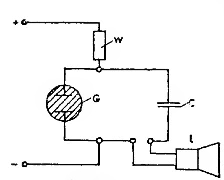


Picture No. 2
Relay contact equipped with induction lamp in the circuit of an electromagnet

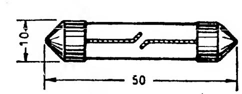
Catalogue No.	Type	For Alternating Voltages volts	For Direct Voltages volts	Approx. weight g	oz.
35 – 08	IR 68	4—60	4—80	4	1/8
35 – 09	IR 1115	60—110	80—150		
35 – 10	IR 2222	110—220	150—220	10	3/8



DGL RELAY GLOW TUBES



Picture No. 1



Type UR 110

Glow tubes for relaxation vibrations are used for the generation of audio frequencies, for measuring of capacitances, stroboscopic tests and the generation of time components. The schematic arrangement of the circuit is illustrated on picture No. 1.

The highly resistive resistor W initiates the gradual charging process of the capacitor C until the glow tube G begins to ignite. The current consumed by the glowing tube discharges the capacitor to the value of the extinguishing voltage of the glow tube and then, this cycle is repeated. The glow current can be heard in headphones or in the loudspeaker L respectively. The difference between ignition and extinguishing voltage is called relaxation amplitude.

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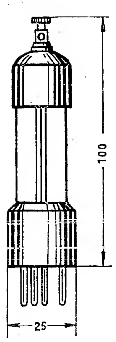


Type KR 150

Relay glow tubes are available in the following types:

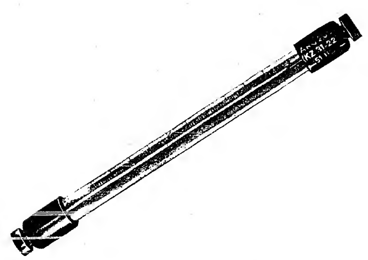
Relay Tube, Type UR 110: ignition voltage below 100 volts; relaxation amplitude approx. 10 volts suited for the range of audio frequencies; series resistor W approx. 1 megohm; capacitor C approx. 1000 cm.

Relay Tube, Type KR 100: designed for higher performance; ignition voltage below 100 volts, relaxation amplitude approx. 15 volts. Dimensions of the circuit elements as mentioned above.

Relay Tube, Type KR 150: ignition voltage 150 volts; relaxation amplitude approx. 50 volts suited for low frequencies below 20 cycles, for maximum performance. The capacitor C may be rated up to 1 mega farad. Resistor W approx. 100 000 ohms. The discharge intensity is sufficient for the operation of relays.

Glow Relay, Type KR 300: ignition voltage approx. 300 volts, relaxation amplitude approx. 150 volts. For synchronisation purposes, the tube is equipped with an auxiliary electrode.

Catalogue No.	Designation	Approx. weight	
		g	oz.
35 – 61	Relay Tube UR 110	4	$^{1}/_{8}$
33 – 01	Relay Tube KR 100	5	$^{3}/_{16}$
33 – 10	Relay Tube KR 150	30	$1\,^{1}/_{16}$
33 – 20	Glow Relay KR 300	30	$1\,^{1}/_{16}$



DGL GRADUATED AMPLITUDE TUBE TYPE ARG 200

The amplitude tube ARG 200 is a glow tube with graduation for orienting measuring. The glow tube is suited for calibration. In the interior of the glass tube, there is a rod-like cathode whose filamentary glow covering changes its length according to the rate of current applied to the tube. The length is read on the graduation.

Since the glow amperage is dependent both on the voltage applied to the tube and on the series-connected resistor, the tube permits measuring of voltages and resistances as well.

In case a fixed resistance is series-connected to the tube, the glow covering represents a measuring unit for the voltage applied.

If the voltage is kept constant, the glow covering represents a measuring unit for the series-connected resistance. If A.C. is applied, the resistor may be replaced by a capacitor permitting even measuring of capacitances.

Applied to A.C., the glow covering is 1.4 times as large as in case of D.C. application. (Peak value). At any rate, the amplitude tube has to be switched in series connection to a resistance. The load of the tube must not exceed the total length of the glow covering. Input current: max. 10 milliamps. The ignition voltage amounts to approx. 180 volts.

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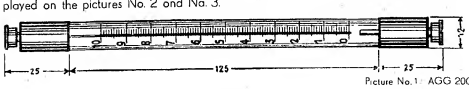
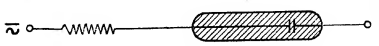
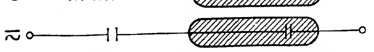
The block diagrams for the measuring of voltages, resistances and capacitances are displayed on the pictures No. 2 and No. 3.



Picture No. 1 AGG 200



Picture No. 2



Picture No. 3

The following tables present the measuring ranges for which the amplitude tube is to be used in practice. If higher voltages are applied, the tube has to be arranged to avoid the danger of touching.

Range of Measuring of the Amplitude Tube, Type ARG 200

Measuring of Voltages		
Constant Resistance	Range of Measuring for Voltages between 1 and 10 cm covering: Direct Voltage	Alternating Voltage, effective
20 kΩ 30 kΩ	175 – 400 V 180 – 500 V	125 – 250 V 125 – 325 V

Measuring of Resistances		
Constant Voltage	Range of Measuring for Resistances between 1 and 10 cm covering: Direct Voltage	Alternating Voltage, effective
200 V eff. 220 V eff. 250 V eff.	100 kΩ – 1 kΩ 150 kΩ – 1,5 kΩ 250 kΩ – 5 kΩ	250 kΩ – 12 kΩ 500 kΩ – 25 kΩ 800 kΩ – 40 kΩ

Measuring of Capacitances			
Constant Voltage	Measuring Range for Capacitances between 1 and 10 cm covering: Alternating Voltage (50 c)	(500 c)	
200 V eff. 220 V eff. 250 V eff.	10000 cm – 0,3 μF 5000 cm – 0,15 μF 3000 cm – 0,1 μF	10 – 300 m 5 – 150 m 3 – 100 m	11 – 330 yds. $5^1/_2$ – 165 yds. 3 – 110 yds.

Catalogue No.	Designation	Weight, approx.	
31 – 22	Amplitude Tube ARG 200	16 g	$^9/_{16}$ oz.

DGL RESO TUBES

as Tuning Indicators for Radio Receiving Sets

DGL Reso Tubes feature

ruggedness against mechanical impacts, thus surpassing indication instruments as to reliability in operation;

a distinctly visible glow light, guaranteeing convenient tuning even in dark rooms;

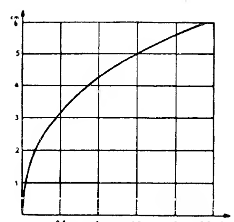
curved characteristic permitting even the tuning of weak transmitters.

As a special distinction, Reso tubes have a longitudinal slot in wich, depending on the load of the tube, the glow light rises or falls like the mercury column of a thermometer. As the diagram (picture No. 1) shows, Reso tubes have the special feature of an increased sensitivity with low currents so that even weak stations may be tuned in. Reso tubes are equipped with an auxiliary anode to secure reliable operation and, last not least, to prevent any quenching of the tube.

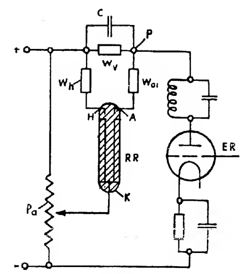
Circuitry

When a Reso tube is incorporated in an amplifier it is to be noted that it should be connected in a valve circuit with changes in the plate current in case of varying strength of reception, i. e., with supercontrolled valves, hexodes, hexogrid valves, detector valves. Picture No. 2 shows the best known wiring diagram. The series resistance W_v (from 5000 to 50000 ohms) is connected in the plate circuit of the supercontrolled valve ER to cause voltage fluctuations of the point P in case of changing current input of the supercontrolled valve ER. The voltage fluctuations are transferred to the anode A of the Reso tube. The capacitor C keeps the high-frequency currents away from the glow tube circuit (approx. 1 μF). The end of the capacitor C opposed to the point P can be applied to the minus terminal of the power source. For the adjustment of the proper working point of the Reso tube, its cathode is biased over a potentiometer P_a (50000 to 100000 ohms) to result in a weak glow covering.

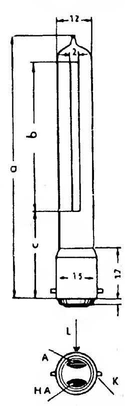
The auxiliary anode H is applied to the plus terminal of the power source across the resistance W_h (1 to 5 megohms). It is recommended to shunt the biasing voltage for the auxiliary electrode directly behind the rectifier to gain maximum biasing. The resistance W_a increases the range of operation of the Reso tube. When this resistance is roted it should be considered that it simultaneously reduces the tube's sensitivity.



Picture No. 1
Glow covering in relation to the tube current



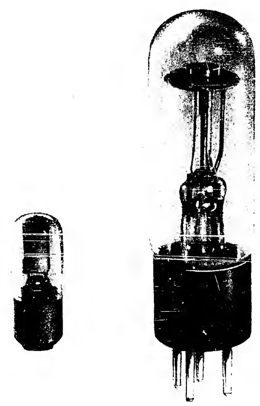
Picture No. 2



Type RR 145/S

Essential Data of the Reso Tube	RR 145/S mm	inch.
Length dimensions	a = 110 b = 65 c = 30	$4^3/_8$ $2^9/_{16}$ $1^3/_{16}$
Controllable length of the glow column	60	$2^3/_8$
Meon ignition voltage	175 volts	
Meon burning voltage	150 volts	
Current requirement	0–2 milliamps.	

Catalogue No.	Type	Approx. weight g	oz.
30–05	RR 145/S	15	$^9/_{16}$

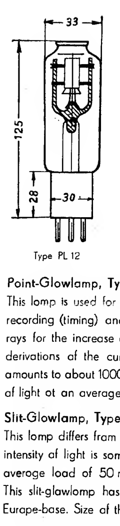


MODULABLE GLOW DISCHARGE LAMPS FOR STROBOSCOPES AND PHOTOGRAPHIC SOUND RECORDING

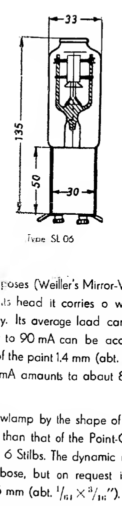
The glow discharge lamps of the present list are used for inertless modulation of light. Of these glow lamps two kinds are known.

The first sort is modulating the intensity of the glowlight and is called "brightness-controlled glow-lamp", and the second kind changes the form of the cathode covering glow light ("covering-controlled glow lamp"). The present list contains the brightness-controlled glow-lamps, and all these lamps work without a hot cathode, and they can, therefore, in a most simple way be connected in circuit.

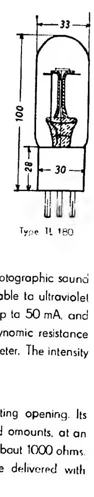
The average working voltage is 180 to 200 volts. The lamps do not have a series resistance so that in operation a series resistance (of at least 500 ohms) must be provided, in order to avoid a damage due to overload.



Type PL 12



Type SL 06



Type TL 180

Point-Glowlamp, Type PL 12

This lamp is used for television purposes (Weiller's Mirror-Wheel), for photographic sound recording (timing) and so on. At its head it carries a window permeable to ultraviolet rays for the increase of its capacity. Its average load can be raised up to 50 mA, and derivations of the current from 10 to 90 mA can be accepted. The dynamic resistance amounts to about 1000 ohms. Size of the point 1.4 mm (abt. $^{1}/_{16}$") in diameter. The intensity of light at an average load of 50 mA amounts to about 8 Stilbs.

Slit-Glowlamp, Type SL 06

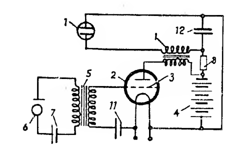
This lamp differs from the Point-Glowlamp by the shape of the light-emitting opening. Its intensity of light is somewhat lower than that of the Point-Glowlamp and amounts, at an average load of 50 mA, to about 6 Stilbs. The dynamic resistance is about 1000 ohms. This slit-glowlamp has a terminal base, but on request it can also be delivered with Europe-base. Size of the slit 0.5 × 5 mm (abt. $^{1}/_{64} \times {}^{3}/_{16}$").

Stroboscope Small Surface Glowlamp, Type TL 180

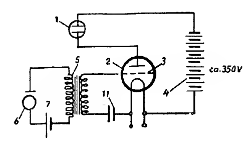
This glowlamp has been provided with a small disc-shaped cathode for the radiation of light. The luminous plane of this cathode has a diameter of 10 mm (abt. $^{13}/_{32}$"). It ... of a strong, brightness-controlled source of light. Its average load amounts to ... mA; its dynamic resistance is in the order of 1000 ohms, and it has a Europe base.

Small slit-Glowlamp, Type KI 14 (see illustration)

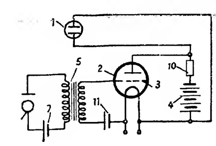
In this lamp the glow-slit is produced in a box-shaped case of electrode of about 2 mm width and of 15 mm length (abt $^{5}/_{64} \times {}^{19}/_{32}$"). The average load is 5 mA. If the lamp is operated at momentary impulses, this average load can essentially be exceeded. The lamp is specially used for relay-testing instruments and is equipped with swan (bayonet) base.



Jll. 1



Jll. 2



Jll. 3

Connection-circuits:

It is recommended to connect the glowlamps in bias voltage in a way that they are already in a glowing state or that they are short before the ignition potential. Only weak alternating amplitudes are then necessary for the modulation of the glowlight.

For a linear modulation the closed circuit current must be greater than the greatest possible modulation-amplitude. The coupling of the glowlamp with the amplifier may be done in a galvanic or in an inductive and capacitive way. The above drawings show various possibilities.

In the circuit of our Jll. 1 the glowlamp is in direct series connection with the amplifying tube. With this method of connection a protective resistance for the lamp is not required. The working voltage should be of such a magnitude that besides the voltage (of an order of 220 volts) absorbed by the glow lamp, a sufficient anode potential is still available for the amplifying tube No. 2.

The figures in our connection drawings mean:

1 = Glowlamp	7 = Microphone battery
2 = Amplifying tube	8 = Safety resistor
3 = Amplifying tube grid	9 = Coupling transformer
4 = Tension source	10 = Coupling resistor
5 = Transformer	11 = Grid bias battery
6 = Microphone	12 = Transmission condenser

In the circuit arrangement, as per drawing 2, the glowlamp is modulated by the transformer No. 9. The resistor No. 8 can be suppressed if the Ohm's resistor of the transformer amounts to at least 500 ohms.

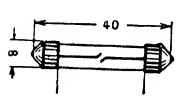
In the drawing No. 3 the glowlamp is connected in parallel to the amplifying tube 2. The two circuits have a common series resistance 10. With increasing input current of the amplifying tube 2 the glow current is reduced, and vice versa.

No. for orders	Type	Denomination	Approx. weight g	oz.
32 – 01	PL 12	Point glowlamp	60	$2\frac{1}{8}$
32 – 30	SL 06	Slit glowlamp	80	$2\frac{13}{16}$
32 – 40	TL 180	Stroboscope Small Surface lamp	40	$1\frac{9}{16}$
32 – 60	KL 14	Small slit lamp	10	$\frac{3}{8}$

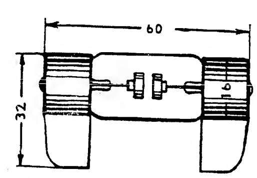
DGL LIGHTNING PROTECTION AND EXCESS VOLTAGE CUT-OUTS

The cut-out glow tubes are available for various operation voltages. They feature top-quality, constant ignition voltage and high current carrying capacity. The tubes with low response voltage are suited for radio equipment since they feature a soft flash-over beginning already below 100 volts.

The type RPS 350 meets the specifications of Deutsche Post and is meant for heavy-duty operation.



Type BS 40



Type RPS 350

Catalogue No.	Type	Response Voltage approx. volts	Approx. weight g	oz.
35–01	BS 40	100	2	$\frac{1}{16}$
35–07	RPS 350	350	27	$\frac{15}{16}$

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SPRAY DRYING

Sushka raspyleniyem [Spray Drying], 1955, Moscow, Pages 14-38; 49-89; 124-144; 158-196

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Candidate in
technical sciences

[Pages 14-38]

CHAPTER II. SPRAY DRYING

Principal Features

Spray drying combines a succession of processes by which solids are separated out of solution by evaporation of the liquid. The solutions are dispersed in the drying chamber by various special devices (rotating discs, jets) through which the heat- and moisture-carrier passes in the gaseous state (hot air, fuel combustion gases, superheated steam, etc).

The large surface area of the dispersed particles makes possible an intensive exchange of heat and mass with the drying agent (the heat carrier), and the dispersed particles rapidly surrender their moisture. The dry product falls to the bottom of the drying chamber as a powder. It is removed by a continuous process involving mechanical scrapers or other devices. Any portion of the dried particles that does not separate out in this manner is precipitated from the rejected gas or air in dust-catchers (cloth filters, cyclones, scrubbers, etc).

The dried particles are usually spherical in form, and may be solid (monolithic), hollow, or sponge-like, depending upon the molecular structure of the solution being dried and the conditions of drying.

There are also other methods of spray drying. They include

drying in vacuum-spray driers or the so-called "cold" spray-drying method. Cold spray drying is used with solutions which exist as liquids in the heated state, but as solids at normal temperatures. These solutions are dispersed in the hot state in a current of cold air. Evaporation results from the heat accumulated by the solution itself.

Spraying may be used to dry any solution capable of being delivered to the dispersal apparatus by pump or pressure.

In view of its distinctive characteristics, spray drying enjoys a number of advantages over other drying methods:

1. Drying goes with extreme rapidity (15 to 30 seconds), and the particles in the zone of elevated temperature display a saturated surface, the temperature of which is close to that of adiabatic expansion of the pure liquid. Due to the fact that drying is instantaneous, and to the relatively low temperature elevation of the dispersed particles of solution, the dried product is of good quality. For example, this process does not denature proteins, nor does it cause oxidation, loss of vitamins, etc. The method is often used in the drying of food products, biologicals, pharmacologicals, and other heat-sensitive materials. In quality, a product dried in spray driers in heated air or inert gas (nitrogen, carbon dioxide) may be compared only to one dried in high vacuum.

2. Spray drying permits ready regulation and variation in any desired direction of the qualitative indices of the final product, by changing the conditions of drying. Thus, the volumetric weight of the dry powder, the size of its particles, their terminal moisture-content, and temperature, may all be adjusted within specific limits.

3. Drying produces a finished product that does not ordinarily require further pulverization, and is of increased solubility.

4. Spray drying often makes possible a marked reduction in the number of operations required to obtain the dry product so that it becomes possible to mechanize the process completely. The stages that may be excluded in this manner include filtration, fuging, grinding, etc.

5. Spray driers permit the attainment of high labor productivity, the number of persons servicing the equipment being small.

6. The solution being dried does not touch the surface of the drier during drying, until it is actually dry. This simplifies solution of problems of corrosion and the choice of materials for the drying chamber. Other drying methods require the wet product to come into contact with metal surfaces.

7. Drying in spray driers may be conducted over a wide range of temperatures (80-800°C).

8. Spray driers may be used to dry viscous amorphous substances from which it is desired to obtain pulverized end products. It is impossible to granulate such substances by methods such as grinding. In addition, only a small quantity of the substance is in the drying chamber at a single time, so that there is no danger of spoiling a large quantity due to unforeseen stoppage of the drier.

9. Spray drying facilitates the production of dried products composed of specific proportions of various dry components, by adding the desired amounts of other solutions to the main solution before drying, or by simultaneous spraying of these various solutions.

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10. The dried substance does not enter the shop as dust, a particularly impo tant consideration in the drying of substances harmful to man.

This method of drying has both advantages and disadvantages, of which the following must be noted:

(1) the equipment is of relatively large dimensions when drying is at an initial air temperature of 100 to 150°C;

(2) the equipment required to spray the solutions and recover the dried products from the exhausted gases is relatively expensive and complex;

(3) the process requires more power, which is needed to spray the solution, and there is a relatively high air consumption, due to the low saturation of the rejected air when initial drying temperatures are low;

(4) the volumetric weight of the dried product is rather low, so that supplementary processes, such as briquetting, are required if given densities are to be obtained.

Despite these shortcomings, spray drying is economical, particularly if the initial moisture-content of the solution is the same as it would be if some other method of drying were used. The cost of drying declines in inverse ratio to the increase in the productivity of the apparatus. The specific consumption of heat per kg of moisture evaporated varies from 850 to 1400 kcal/kg, depending upon the conditions of drying.

In addition, the economics of the method are improved if the process of evaporation in the spray drier is intensified. As has

been found in practice, the drying of solutions in high dispersion permits a marked stepping-up of the process, permitting reduction in the dimensions of the apparatus and in the consumption of power and heat.

The spray drying process may be stepped up as follows:

(1) by increasing the dispersion of the solutions being sprayed, i.e., by dividing the particles more finely through the use of sprayers of appropriate design;

(2) by obtaining a more uniform dispersion, meaning that the limits of variation of the diameter of the drops in the jet are restricted;

(3) by increasing the temperature limit of the drying agent in the drying of solutions sensitive to heat. It is essential, if this be done, that the drying agent and the solution being sprayed, move in parallel directions.

The first and second methods of intensification are used in efforts to improve existing spray apparatus and to create new ones. It must be noted that, as the size of the dispersed particles in the solution decreases, the problem of recovering the dried product becomes more complex.

Intensification of the drying process by raising the initial temperature of the drying agent makes it possible to improve the economy of the method while maintaining the quality of the finished product. Positive results in this direction have been obtained by the Drying Laboratory of the Dzerzhinskiy All-Union Heat Engineering Institute, and a number of high-intensity drying processes have now been introduced into industry.

As noted above, spray drying is governed by its 3 fundamental processes: the spraying of the solution, the mixing of the gas and the particles of solution, and the exchange of heat and mass between them. In addition, the elimination of the dry particles from the flow of gases is intimately involved in spray drying. The correlation of all these processes determines the effectiveness of the drying and the industrial and economic indices of spray installations.

The Characteristics of Solutions

By solutions we understand an extensive class of dispersed wet materials, which, under given conditions of temperature, pressure, moisture, etc, are possessed of one common physical property -- fluidity.

All solutions may be regarded as consisting of 2 phases if we think of them as dispersed systems. The dispersion medium in this concept is the moisture (liquid) which is completely or partially eliminated in the process of drying, and the dispersed phase is composed of the substances precipitated on drying.

All solutions may be divided into the following 3 groups, in accordance with the size of the particles of the dispersed phase:

(1) coarse dispersions, in which particle diameters are greater than one μ ;

(2) medium dispersions, in which the particle size is from one to 0.1μ;

(3) colloidal solutions, in which the particle size is under 0.1μ.

When the particles are reduced below the last of these sizes,

down to molecular size, the second phase disappears, and the solution becomes a true molecular solution. True solutions become diphasic systems in the process of drying. As the solution becomes concentrated, the monophasic molecules begin to combine, forming the seeds of a second phase within the previously homogeneous solution. Further aggregation results in the formation of a new phase.

Solutions may be divided into 2 categories by the state of aggregation of the phases: those having liquid, and those having solid surfaces of separation. The first category includes emulsions (milk, butter, etc), and the second, suspensions.

Solutions are classified as lyophilic and lyophobic by the intensity of molecular action at the surface of separation.

In lyophilic solutions the dispersed phase is completely interpenetrated by the dispersing medium, i.e., the system is monophasic, as it were. Examples of this are solutions of proteins and gelatin in water. Examples of hydrophobic solutions are offered by metal sols, aqueous suspensions of vat dyes, etc.

Lyophilic solutions resist surrendering their moisture, as they are bound more closely than the lyophobic.

Thus, we shall classify all solutions as follows in terms of the spray drying process:

(1) lyophilic colloidal solutions;

(2) lyophobic solutions, which include colloidal solutions and suspensions with a solid surface of separation of the 3 groups listed above by particle size;

(3) true solutions.

As we shall demonstrate, use of this classification permits clear explanation of the various mechanisms of drying of the drops in a solution, the changes in their size during the drying process, variation in the volumetric weight of the dry powder, etc.

Characteristics of the Dispersion of a Spray and a Dry Powder

Let us note at the outset that the concept of dispersion, as the relation of the surface of an object to its volume, is from thermodynamics, i.e., it is a criterion for the development of the surface of separation of 2 phases, for example, the solid and gaseous. The greater the extent of the phase boundary between the 2 phases per unit volume of substance, or the smaller the particle diameter, the greater the dispersion.

In spray drying, solutions are dispersed into very fine particles in order to intensify the process of evaporation of moisture by increasing the phase boundary surface (of liquid and gas). As a result of the drying process, the finished product usually takes the form of a powder, also consisting of fine solid particles differing in shape and size. The degree of dispersion of the powder affects the physicochemical properties of the dried product (color, volumetric weight, capacity to flow freely, solubility, etc). If we know the dispersion of the spray we can determine the efficiency of the spray apparatus, and can predict the drying process. Thus, the spray method of drying requires more detailed attention to the fundamental characteristics of dispersed systems and the experimental methods of determining them.

The dispersion of a liquid by special devices yields a semidispersed spray consisting of particles differing in size, but of adequate homogeneity. Thus, N. S. Ponaserkov (35), analyzing

dried milk produced by drying in a centrifugal disk spray drier, concluded that the milk components were distributed equally in the individual particles of dispersion. The only difference between these particles consisted of their size (diameter). In the dispersal of solutions, the dispersed particles are usually spherical in form. Thus, the totality of the particles obtained in a dispersed solution is structureless, the spray process affects the mass as a whole, and is subject to the laws of statistics. Experimental studies of the spraying of solutions have shown that the distribution of the particles in the spray by diameters is usually of the same nature under various conditions and methods of spraying. The same holds for the composition of the dry powder by grain size distribution.

One of the fundamental characteristics of dispersed systems is the curve of distribution by particle diameter. The distribution curve may be expressed in the volumes of each class (fraction) or by the number of particles in the class.

If we group the particles in classes whose boundaries are within the limits of $\breve{\sigma} + \frac{\Delta\breve{\sigma}}{2}$ and $\breve{\sigma} - \frac{\Delta\breve{\sigma}}{2}$ changes in diameter within the dispersed system from $\breve{\sigma}_{min}$ (minimum diameter) to $\breve{\sigma}_{max}$ (maximum diameter), we obtain a distribution diagram, shown in Figure 3a. The area below the curve is unity. If the total number of particles is great and the interval $\Delta\breve{\sigma}$ approaches zero ($\Delta\breve{\sigma} \rightarrow 0$), the distribution diagram may be represented by a smooth curve.

If in each fraction, we take not the number of particles of diameter $\breve{\sigma}_i$, but their volume, we obtain what is termed the volumetric distribution curve. This curve is displaced toward the larger particles, as the volume of the particles in the fraction is proportional to $\breve{\sigma}^3$. The volume below the distribution curve

is unity. Sometimes the integral of the distribution curve is used to characterize dispersion. In that case, the diameter of the particle is plotted on the abscissa, and the total volume of all particles whose diameter is less than δ_i is plotted on the ordinate. The volume of the particles (Figure 3b) ranges from 0 to 1.0. Sometimes the volume of the various fractions is given in percentage.

The simplest type of statistical system may be determined by the function of distribution with its characteristic variables. However, in certain cases, it is more convenient to use, not the entire distribution curve expressed by some specific function, but the mean diameter of the particles in the dispersed system.

In this case, the polydispersed system is replaced by a monodispersed system in which the average particle size is calculated in some definite manner. The average diameter is the spray characteristic and is determined by the distribution curve and the method of averaging.

Let us consider the main methods of taking an average. The method used is selected in accordance with the physical phenomenon in which the given dispersed system is participating. For example, let us take some process proceeding according to the following rule

$$\frac{dG}{d\tau} = -k\delta, \qquad \text{(II-1)}$$

in which $dG/d\tau$ is the rate at which the substance loses weight, δ is the diameter of the particle, and k is the constant for this equation.

For particles of differing diameters we will, as a result, have the following equation

$$\frac{d(\Sigma G)}{d\tau} = -k\Sigma\delta \quad . \qquad \text{(II-2)}$$

Substituting the average linear diameter $\delta_{1,0}$, for the total number of particles we obtain

$$\frac{dGav}{d\tau} = k\delta_{1.0} \qquad \text{(II-3)}$$

From Equations (II-3) and (II-1), we see that Equation (II-1) is valid both for the average diameter of the particle and for a single particle, if the average linear diameter of the particle be employed.

The average linear diameter $\delta_{1.0}$ is determined on the basis of the fractional composition or the distribution curve of the dispersed system on the equation

$$\delta_{1,0} = \frac{\Sigma \delta_i^1 \Delta n_i}{\Sigma \Delta n_i}$$

or

$$\delta_{1.0} = \frac{\int_{\delta_0}^{\delta_m} \delta^1 \frac{dn}{d\delta} d\delta}{\int_{\delta_0}^{\delta_m} \frac{dn}{d\delta} d\delta}, \qquad \text{(II-4)}$$

where δ_i is the discrete diameter of the particle

Δn_i is the number of particles, the diameter of which is δ_i while

δ_0 and δ_m are, respectively, the minimum and maximum particle diameters.

The subscript, 1, with the average diameter, signifies the power to which the magnitude of the particle diameter is entered in the denominator.

The average is determined by various methods, depending upon the process in which the given dispersed system is involved. The method encountered most frequently is the following:

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(a) average surface diameter $\delta_{2.0}$

$$\delta_{2,0} = \sqrt{\frac{\Sigma \delta_i^2 \Delta n_i}{\Sigma \Delta n_i}}$$

or

$$\delta_{2,0} = \sqrt{\frac{\int_{\delta_0}^{\delta_m} \delta^2 \frac{dn}{d\delta} d\delta}{\int_{\delta_0}^{\delta_m} \frac{dn}{d\delta} d\delta}}; \qquad \text{(II-5)}$$

(b) average volumetric diameter

$$\delta_{3,0} = \sqrt[3]{\frac{\Sigma \delta_i^3 \Delta n_i}{\Sigma \Delta n_i}}$$

or

$$\delta_{3,0} = \sqrt[3]{\frac{\int_{\delta_0}^{\delta_m} \delta^3 \frac{dn}{d\delta} d\delta}{\int_{\delta_0}^{\delta_m} \frac{dn}{d\delta} d\delta}}; \qquad \text{(II-6)}$$

(c) average volumetric and superficial diameter

$$\delta_{3,2} = \frac{\Sigma \delta_i^3 \Delta n_i}{\Sigma \delta_i^2 \Delta n_i}$$

or

$$\delta_{3,2} = \frac{\int_{\delta_0}^{\delta_m} \delta^3 \frac{dn}{d\delta} d\delta}{\int_{\delta_0}^{\delta_m} \delta^2 \frac{dn}{d\delta} d\delta}; \qquad \text{(II-7)}$$

If the first subscript, at average diameter, be designated by the letter f, and the second by k, we may write the following for the general case

$$\delta_{f,k} = \sqrt[f-k]{\frac{\Sigma \delta_i^f \Delta n_i}{\Sigma \delta_i^k \Delta n_i}}$$

or

$$\sqrt[f-k]{\frac{\int_{\delta_0}^{\delta_m} \delta^f \frac{dn}{d\delta} d\delta}{\int_{\delta_0}^{\delta_m} \delta^k \frac{dn}{d\delta} d\delta}} \qquad \text{(II-8)}$$

If the distribution curve be expressed in volumetric terms, the equation for average diameter will be

$$\delta_{f,k} \sqrt[f-k]{\frac{\Sigma \delta_i^f \Delta V_i}{\Sigma \delta_i^{k-f} \Delta V_i}}$$

or

$$\sqrt[f-k]{\frac{\int_{\delta_0}^{\delta_m} \delta^f \frac{dV}{d\delta} d\delta}{\int_{\delta_0}^{\delta_m} \delta^{k-f} \frac{dV}{d\delta} d\delta}}. \qquad (II\text{-}9)$$

Table 4 adduces the fields in which the various average particle diameters are employed.

The table shows that in solution spraying processes, heat and mass exchange occurring in the drying of dispersed systems must be averaged by the use of Equation (II-7), i.e., the average volumetric and superficial diameter must be calculated. Under this method of averaging, the polydispersed spray is replaced by one of homogeneous dispersion in such a manner as to cause no change in the size of the surface of the particles in the actual dispersed system.

TABLE 4

Average diameter	f	k	Field of employment
Linear	1	0	Comparison
Superficial	2	0	Regulation of surface
Volumetric	3	0	Regulation of volume
Volumetric-superficial	3	2	Heat and mass exchange, chemical reactions
Gravimetric	4	3	Combustion

Currently, various distribution functions are used for the curves shown in Figure 3a, depending upon the nature of the dispersed

system. Let us analyze several of the distribution functions δ, which are most frequently employed in practice for dispersed systems.

In atomizing solids, the following function of volumetric distribution in accordance with particle diameter is commonly used:

$$\frac{dV}{d\delta} = \frac{\xi\delta^{\xi-1}}{\delta_{av}^{\xi}} e^{-\left(\frac{\delta}{\delta_{av}}\right)^{\xi}}, \qquad (II\text{-}10)$$

in which V is the volume of particles of diameter smaller than δ_i; δ is the particle diameter; ξ and δ_{av} are constants experimentally determined, ξ being the distribution, and δ_{av} the characteristic size of the particles; e is the base of the natural logarithm, e = 2.718.

For distribution by number of particles, this function will look thus:

$$\frac{dn}{d\delta} = \frac{\xi\delta^{\xi-4}}{\delta_{av}^{\xi-3}\Gamma\left(1-\frac{3}{\xi}\right)} e^{-\left(\frac{\delta}{\delta_{av}}\right)^{\xi}}, \qquad (II\text{-}11)$$

in which $\Gamma(1-3/\xi)$ is the gamma function, determined by special tables. (I. N. Bronshteyn and K. A. Semendyayev, Spravochnik po matematike dlya inzhenerov i uchashchikhsya vtuzov [Mathematical Handbook for Engineers and Students in Institutes of Technology], Government Technology Press, 1954).

For the purpose of finding the values of ξ and δ_{av} on experimental data, it is convenient to present Equation (II-10) after integration and determination of the log log as follows:

$$\ln\ln\frac{1}{1-V} = \xi(\ln\delta - \ln\delta_{av}) \qquad (II\text{-}12)$$

If the value ln ln $\frac{1}{1 - V}$, and ln δ is plotted on the abscissa, we obtain a line corresponding to a linear equation. When this line is plotted on the points found by experiment it is not difficult to find ξ as the tangent to the angle of slope of the line, and δ_{av} as the value of δ for which $1 - V = e^{-1}$

When solutions are to be sprayed by means of pressure nozzles, certain researchers employ the following empirical equation for quantitative distribution of the particles:

$$\frac{dn}{d\delta} = B\delta^2 e^{-b\delta^\xi}, \qquad \text{(II-13)}$$

in which B, b and ξ are constants in the equation.

The value of B relates to the total volume of the specimen taken for study.

ξ characterizes the degree of homogeneity of the dispersed system. The greater the value of ξ, the more homogeneous the dispersed system.

The curve of distribution by volume will be

$$\frac{dV}{d\delta} = \frac{b^{6/\xi}}{\Gamma(6/\xi)}\delta^5 e^{-b\delta^\xi}. \qquad \text{(II-14)}$$

To determine the constants b and ξ by experimental data, equation (II-13) must be rewritten as follows

$$\lg\frac{dn}{\delta^2 d\delta} = \lg B - \frac{b\delta^\xi}{2.3}. \qquad \text{(II-15)}$$

Thus, by applying lg $\Delta n/\delta^2\Delta\delta$ as a function of δ^ξ, we obtain a straight line when the value chosen for ξ has been properly selected. In accordance with the experimental data, the magnitude of ξ fluctuates within the range of 1, + 1/2, + 1/3, + 1/4 when solutions are sprayed by compressed air. From the plotting of the

straight line it is easy to determine, by the tangent to the angle of ψ, the slope of its constant, b:

$$b = 2.3 \operatorname{tg} \psi$$

The following equation for volumetric distribution is arrived at by the methods of statistics:

$$\frac{dV}{dx} = \frac{\xi}{\sqrt{\pi}} e^{-\xi^2 x^2}, \qquad \text{(II-16)}$$

in which ξ is a coefficient describing the deviation from the magnitude x.

If we assume the power of the exponent to be greater than linear, the following expression for x must be used:

$$x = \ln \frac{\delta}{\delta_{av}}, \qquad \text{(II-17)}$$

in which δ_{av} is the average diameter.

The equation for distribution by number of particles will be

$$\frac{dn}{dx} = \frac{\xi}{\sqrt{\pi}} e^{-\left(\xi x + \frac{3}{2\xi}\right)^2}. \qquad \text{(II-18)}$$

To find the constants ξ and δ_{av}, let us integrate equation (II-16), from which we obtain:

$$V = \frac{1}{\sqrt{\pi}} \int_{-\infty}^{\xi x} e^{-\eta^2} d\eta = \frac{1}{\sqrt{\pi}} \int_{0}^{\xi x} e^{-\eta^2} d\eta + \frac{1}{\sqrt{\pi}} \int_{-\infty}^{0} e^{-\eta^2} d\eta, \qquad \text{(II-19)}$$

in which η is the variable of integration.

In equation (II-19), the second integral equals $\frac{1}{2}$, so that we emerge with the following expression for volume:

$$2V - 1 = \operatorname{erf}\left[\xi \ln \frac{\delta}{\delta_{av}}\right]. \qquad \text{(II-20)}$$

(erf y = Gauss' function of error)

Plotting on the abscissa the argument z = erf (2V-1), and on the ordinate lg δ/δ_{av}, we obtain a linear function. ξ may be determined by the slope of the straight line plotted on the experimental data for the fractional composition of the dispersed system, if one use any 2 points on that straight line.

For example, let us take the points representing 20 and 90% fractions by volume (see Figure 4d). Here ξ may be found from the equation

$$\xi = \frac{0,653}{\lg \frac{\delta_{0,9}}{\delta_{0,2}}} = \frac{0,394}{\lg \frac{\delta_{0,9}}{\delta_{cp}}}, \qquad (II\text{-}21)$$

in which $\delta_{0.9}$ and $\delta_{0.2}$ are the diameters of particles in a dispersed system corresponding to 90 and 20% fractions, and δ_{av} is the average diameter corresponding to 50% of the volume of the fraction: $\delta_{av} = \delta_{0.5}$.

In the equations adduced, the distribution of particle diameters varies in the limits from 0 to infinity, which certainly does not correspond to reality. Therefore, in order to limit change in particle diameter within the function to some specific interval, the expression used for x may be as follows:

$$x = \ln \frac{a\delta}{\delta_{max} - \delta}. \qquad (II\text{-}22)$$

in which δ_{max} is the maximum dimension of the particle, and a is the constant for the equation.

In this expression, the maximum particle diameter, δ_{max}, is taken as the basic parameter, instead of the average diameter for 50% of the volume of the fraction. The maximum particle size, δ_{max}, is determined on experimental data. The constants for equation II-22 are determined by the plotting of a straight line representing the volumetric distribution curve within the coordinates

$$\operatorname{erf}(2V-1) \text{ и } \lg\frac{\delta}{\delta_{max}-\delta}.$$

When V = 0.5, equation II-20 gives us $x = 0$, so that

$$a = \frac{\delta_{max}-\delta_{0.5}}{\delta_{0.5}}. \qquad \text{(II-23)}$$

in which $\delta_{0.5}$ is the particle diameter corresponding to a fraction whose volume is 0.5 (50%).

The constant ξ is determined from the tangent to the angle of slope of a straight line, by analogy to equation (II-21).

Depending on the functional relationship accepted for the distribution curve for particle diameter in a dispersed system, the average volumetric-superficial diameter may be determined by the following formulas:

for Equation (II-10)

$$\delta_{3,2} = \frac{\delta_{cp}}{\Gamma\left(1-\frac{1}{\xi}\right)}; \qquad \text{(II-24)}$$

for Equation (II-13)

$$\delta_{3,2} = b^{-\frac{1}{\xi}}\frac{\Gamma\left(\frac{6}{\xi}\right)}{\Gamma\left(\frac{5}{\xi}\right)}; \qquad \text{(II-25)}$$

for Equations (II-16) and (II-17)

$$\delta_{3,2} = \delta_{cp}\, e^{-\frac{1}{4\xi^2}}; \qquad \text{(II-26)}$$

for Equations II-16 and II-22

$$\delta_{3,2} = \frac{\delta_{max}}{\left[1+ae^{+\frac{1}{4\xi^2}}\right]}. \qquad \text{(II-27)}$$

Up to the present, inadequate experimental data have been accumulated on the dispersion of the spray in various sprayers and solutions. It is therefore not yet possible to decide once and for all that some single functional relationship for the distribution curve is the most rational.

We adduce, in Figure 4, by way of an example for the comparison of the functional expressions, experimental data on the dispersion composition of nickel oxalate powder obtained by spray drying with pressure nozzles. Figure 4 shows that the experimental points for the functional expressions of the distribution curve employed fall reasonably well along a straight line in all 4 cases. From the straight line plotted in the appropriate coordinates, determination was made of the constants for each equation, and the average volumetric-superficial diameters of the particles were calculated, in microns. These data are adduced in Table 5.

TABLE 5

Equation	Constants within each equation					
	δ_{av}		b	a	δ_{max}	$\delta_{3,2}$
II-10	37.0	2.0	--	--	--	20.9
II-13	--	0.5	2.02	--	--	27.0
II-16, II-17	30.0	1.16	--	--	--	24.7
II-16, II-22	--	0.774	--	2.69	112.5	22.5

The table shows that the average volumetric-superficial diameter of the particles in the powder were found to be between 20.9 and 27 μ, while when calculated directly from the fractional composition of the powder, the volumetric-superficial diameter proved to be 23.5 μ. Comparison shows that the functional expression for the distribution curve in accordance with equation (II-16) proved to be the most satisfactory. Figure 5 adduces experimentally determined points on the distribution curve for powder particle diameter, and distribution curves plotted on equations (II-10), (II-13), and (II-16).

Methods of Experimental Determination of the Dispersion of Sprays and Dry Powder

There are differences between the methods of determining the dispersion of a dry powder and the drops in a spray.

To determine the dimensions of dry particles, various methods may be used:

(1) linear measurement in the microscope (in visible or ultraviolet light);

(2) passage through an opening of known size;

(a) through standard mesh sizes,

(b) through graduated membranes,

(3) by the packing of the particles,

(4) by the effect of particle sizes on electromagnetic waves,

(5) by the movement induced in the particles by known forces:

(a) using a current of known speed to observe separation (winnowing") from gas or liquid,

(b) by gravity (determination of rate of precipitation),

(c) by centrifugal force (determination of the rate of displacement from the center)

(d) by means of an electrical field.

The methods in points 1, 2, 4, and 5 above permit determination of particle distribution by size, but not the shape of the particle (except for method 1, involving use of the microscope in visible light.)

Let us give more detailed attention to the methods of determining particle size most frequently encountered in practice.

Determination of particle size by microscope presents no great difficulty. However, it must be noted that more precise determination of particle size requires microphotography to a magnification previously determined, depending upon the dispersion of the powder. An advantage of this method is the fact that it affords the possibility of estimating particle shape. Particles down to 0.4 μ in size may be seen with the microscope, and particles down to 0.1 μ may be seen by means of ultraviolet light. The sensitivity of microanalysis increases when the electron microscope, permitting particles down to 0.001 μ to be seen, is used. This method has its disadvantages. The measurement and counting of particles under the microscope is a very difficult operation, as, in order for exact data to be obtained a considerable number of particles (not under 1,000) must be counted.

Standard Screens

The use of standard screens permits the size of particles to be determined by their ability to pass apertures of given size. This is the method normally employed to measure particles over 40 μ in size.

Determination of the dispersion of powder, or screen analysis, consists of sifting a specimen through a succession of screens of various mesh sizes. In this process the fine particles pass through the mesh, and the larger ones remain above it. That portion which remains on the screen is called the screenings, and is measured in percentages of the initial quantity. The portion that passes through the screen is called the undersize or minus material.

The process of screening is performed as follows. The specimen is subjected to preliminary drying. The purpose of this is to prevent moist particles from clotting and fouling the screen. The sample for analysis is 25 to 50 g. The powder is sifted through either by hand or on special machines (shakers).

In hand screening the powder specimen is sifted onto the topmost screen, and the whol series of screens are enclosed with a cover and floor. Sieving is performed by shifting the screen being rotated constantly to make fullest use of its area. The duration of screening should be 15 to 20 minutes. Machine screening employs special devices (shakers, Figure 6), which should, if possible simultate the motions performed by the human hand. Figure 6a shows a sifter in which the screen is rotated and at the same time strikes a stop. In addition the operator drums with his fingers on at the screen housing. In the machine shown in Figure 6b, the screen rotates on an excentric and is agitated by cams striking the screens from above. The number of screens for which it is desired to measure the screenings are set up in the machine on stops. The coarsest screen is placed at the top, and the finest at the bottom. The powder specimen is placed on the top screen. The whole set of screens, with a cover on top, and a trap beneath, is fastened in the agitator. The machine is then usually run for 20 minutes.

After sifting is ended, the powder on each screen is weighed. The size of the screenings over each screen lies between the mesh sizes of the screen above and below it. Screen analysis is usually stated in terms of the percentage of screenings over each screen relative to the weight of the sample used.

A shortcoming of this method is the difficulty encountered

in screening materials which clog the mesh. In addition, the particles undergo some reduction in size during the sifting. The duration and method of sifting also affects the results of screen analysis.

The Packing Method

This is based on determination of the surface area of the dispersed powder by the resistance of a layer thereof to the passage of a given amount of air. This method is satisfactory with particles up to 50 μ in size. Figure 7 adduces the design of V. V. Tovarov's apparatus for this purpose (39). It consists of a container, 1; an aspirator-manometer, 2; a cock, 3; and a vacuum regulator, 4. A layer of powder is placed in the container. A water-jet pump is used to create a vacuum, controlled by the regulator, which causes the liquid in the closed bend of the manometer to rise. When the cock, 3, is closed, the liquid flows from the closed to the open bend, and forces the air through the layer of powder. To determine the surface area of the powder, very careful measurement of the thickness of the layer thereof is necessary.

The specific surface area of the powder, f, is calculated from

$$f = \frac{k}{\gamma} \sqrt{\frac{\varepsilon^3}{(1-\varepsilon)^2}} \sqrt{\frac{1}{\eta}} \sqrt{\tau} \text{ cm}^2/\text{g}, \qquad \text{(II-28)}$$

in which k is a constant effective in the apparatus,

γ is the density of the material in g/cm^3,

ε is the porosity of the powder, equivalent to

$$\varepsilon = \frac{V\gamma - g}{V\gamma}, \qquad \text{(II-29)}$$

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(g being the weight of the sample in grams and V the volume of the layer of material in cm^3),

η is the coefficient of viscosity of the air in poises, and

τ is the time required for the air to pass through, in seconds.

The apparatus constant, k, is determined with the aid of a standard powder of known surface area. The value of k is calculated on the formula

$$k = \frac{f_{\vartheta} \gamma_{\vartheta}}{\sqrt{\frac{\varepsilon_{\vartheta}^3}{(1-\varepsilon_{\vartheta})^2}} \sqrt{\frac{1}{\eta_{\vartheta}}} \sqrt{\frac{1}{\tau_{\vartheta}}}}. \qquad \text{(II-30)}$$

The subscript, Э, refers to the standard powder.

Determination of the average reduced diameter of the particles of powder is easily arrived at by means of the calculated surface of the powder and the specimen.

The Sedimentometric Method

This is based on the precipitation of the particles in an inert medium. The density of a column of suspension changes vertically as particles settle. Therefore, measurement of change in the height of the column during the process of settlement permits determination of the dimensions of the particles coming down out of suspension. This method is applicable for particles under 100 μ in size. The particles must not precipitate in a medium of a viscosity greater than the maximum value of the Reynold's number, 1 (Re $\leq$ 1). Many instruments have been developed on the principle of the precipitation of particles in viscous media. Here we discuss the Figurovskiy-Margolin apparatus (30), (Figure 8).

The apparatus consists of a beaker, 1; containing the suspension

to be tested, a float, 2, a rotating quadrant, 3, carrying a weight and mirror, and a source of light, 4. The principle of operation is as follows. After the suspension has been stirred to clouding, the float is immersed in it to a depth of 500 mm or more. The float is suspended by a thread from one end of the quadrant. The quadrant rotates on its axis as the particles precipitate. This displacement of a scale is read by means of a beam of light reflected from the mirror. When settlement is complete, the pencil of light will have travelled through a distance, l, not shown in the Figure.

If we deal with particle precipitation in accordance with Stokes' Law, we will emerge with the following expression for determining particle diameter:

$$\delta = \sqrt{\frac{18\,\eta}{g\,(\gamma_ч - \gamma_c)}} \cdot \sqrt{\frac{H}{\tau}}\ \text{см}, \qquad \text{(II-31)}$$

in which η is the coefficient of viscosity of the medium, in g/cm per second, g is the acceleration of gravity in cm/sec^2; γ_4 and γ_c are the densities of the particles and the medium, respectively, in g/cm^3; τ is the duration of precipitation, in seconds; and H is the thickness of the layer out of which the particles have precipitated, in cm (see Figure 8).

The distance traversed on the scale during the time required for the $\delta_1 - \delta_2$ fraction to precipitate, is l_1. This fraction will therefore constitute the following percentage of the whole

$$\varepsilon = \frac{l_1}{l}\,100\%. \qquad \text{(II-32)}$$

The concentration of the suspension used is usually 12 to 15 g/lit, 30 g for coarse suspensions. The cylinder must be 600 to 650 mm high, and its diameter 70 to 100 mm. With inorganic materials,

a plexiglass float is used. In the float, the height of which is h, there is a hollow in which shot pellets may be placed to give the float the desired mass. Figure 8b illustrates the design of the apparatus, and its spring.

The Separation Method

This is founded on division of the particles of the dispersed powder in a current of air. An air-powered classifier, consisting of a vertically-mounted cylinder, blows particles up from below in a current of air of given velocity. The speed at which the particles soar is slower than the velocity of the air in the cylinder. The average dimensions of the particles of each fraction may be calculated on the results of slight changes in the air velocity, and determination of the weight of the fraction lost in the air stream. The separation method permits determination only of a tentative dimension of the particles in a given lost fraction. Calculation of the dimensions of the particle on the data of aerial separation is performed most simply by Stokes' formula. This method yields good results in determining the dispersion of powder with particles not larger than 50 μ in size. A serious shortcoming of this method is the long period required to "winnow" the material, sometimes lasting several days.

Methods of Determination of Drop Size in a Spray

There are various methods of determining drop size in a spray. Some are based on taking specimens of the drops in the jet stream, others on the direct determination of the average diameter of the drops in the spray.

Existing methods permit determination of the composition of the dispersion only within a limited portion of the spray stream.

Therefore, to determine the dispersion of the entire jet it is essential to take measurements at various points in the stream. At the same time, the density of irrigation at those points is measured, in order, by calculation, to arrive at the complete dispersed composition of the spray as a whole.

The Optical Method.

This permits determination only of the average size of the drop in a spray. This method is founded on the change occurring in the intensity of light as it traverses a layer of dispersed liquid. The loss in intensity is measured by spectrophotometer. To determine the average size of a drop, one must know relationship to the ratio of light intensity after travelling through spray to light intensity without spraying. If one assume the drop to be opaque (an accurate assumption for highly light-absorbent substances), the loss in light intensity will be the result primarily of the screening effect of the drop. For such cases, professor V. I. Blinov (6) recommends the following formula for loss in light intensity as the result of passage through a layer of spray droplets:

$$I = I_0 e^{-\pi\left(\frac{\delta_{cp}}{2}\right)^2 nh}, \qquad \text{(II-33)}$$

where I and I_0 are the intensity of light in the presence and absence of spraying, respectively,

δ_{av} is the average diameter of the drop,

n is the number of drops cm^3 and

h is the thickness of the layer, in cm, traversed by the drop.

If one measure the amount of liquid flowing past the given cross-section, the average drop diameter may be determined on the formula:

$$\delta_{cp} = \frac{3}{2} \cdot \frac{h}{su} \cdot \frac{G}{\ln \frac{I_0}{I}}, \qquad \text{(II-34)}$$

in which s is the cross section of the beam of light,

u is the rate at which the drops fall, and

G is the amount of liquid passing section s in time τ .

Figure 9 adduces a schematic of an apparatus for determining the average drop diameter. It consists of light sources, 1; lenses, 2; a prism providing complete internal reflection, 3; and a spectrophotometer, 4. The sprayed liquid passes through a slit of determinate thickness, 5. Its size is governed by the distance between the troughs 6. A special trough 7, serves to collect the water passing through the beams of light. The rate at which the drops fall is determined by a special device employing a kymograph. The refraction and reflection of light from the drops renders the photometric method less than accurate. In addition, in a polydispersed spray the rate of fall of drops of varying sizes is not identical and this is also a source of error.

Another method of determining the average diameter of drops in a spray is the "corona" approach. This method is based on the fact that diffraction rings are set up when a punctuate source of light is directed at a fog of droplets. The average diameter of the drops may be determined from the size of the ring, the angle and wave-length of the light. However, when used with polydispersed sprays, the results obtained in successive determinations do not show agreement.

Determination of Drop Size by its Trace

If drops of liquid strike a flat surface covered with a sensitive compound, a trace will be left on the surface thereof.

A fine layer of soot is usually used to obtain a clear trace. Soot has advantages over other substances, as the carbon particles are small and do not wet. The size of the trace is determined by microscope. However, its size is not identical with the diameter of the drop, which undergoes deformation as it strikes the surface. The deformation depends upon the velocity on impact and the physical properties of the drop. If one know the relationship between change in drop trace size and velocity of impact and the physical properties of the drop, the true diameter of the drop may be determined.

The degree of deformation of the drop as it strikes the solid surface depends chiefly upon the forces of inertia and surface tension. If viscosity, gravity, and compressibility exercise insignificant effect in deforming the drop, the criterion determining the ratio of the drop imprint to its original diameter, will be the ratio of the force of inertia to the force of surface tension.

Stoker (52) found, by experiment, the following expression for the diameters, δ, of drops of water and mercury:

$$\delta = 1{,}25 \cdot \frac{\delta'}{\left(\frac{\gamma \delta' u^2}{\sigma}\right)^{\frac{1}{6}}}, \qquad \text{(II-35)}$$

in which δ' is the size of the imprint of the drop,

γ is the density of the drop,

u is the velocity of the drop on impact, and

σ is surface tension.

Figure 10 presents an abbreviated schematic of the instrument used to determine drop size. It consists of a chamber, 1, through

which a vacuum pump takes in air containing drops suspended therein. The chamber has a shutter to permit control over the number of drops striking the plate. The soot-covered plate, 2, is mounted vertically in the path of the drops.

Methods of Drop-Size Determination by Drop Sampling

One of the most widely-used methods of determining the dispersed composition of sprayed liquid is that of trapping drops on microscope slides or special traps. To prevent the drops from sliding off, being broken up into finer sizes, or combining, the traps or slides are filled with a liquid inert relative to that being sprayed. Castor, machine, or bone oil, or certain synthetic lacquers, are usually used. In highly-atomized sprays, castor oil is not suitable, as the fine drops are incapable of traversing the thickened superficial layer of the liquid.

Sometimes slides are covered not with liquid but with a thick coat of soot of magnesium oxide. The drops falling into the trap settle at its bottom or remain in suspension, depending upon the density of the liquid.

The method of determining the dispersed composition of a spray consists of the following. The atomized stream usually reveals a circular symmetry relative to the size of the particles and the density of the current, if the axis of the atomizer is vertical. Therefore, sampling at any radius of the atomized jet will describe its weight.

The jet stream is divided into a series of concentric circles of specific size. In each ring, the density of the current is measured along a radius, and the dispersed composition of the spray

is determined. Toward this end traps are set along this radius. The traps are housed in a container with a curtain shutter. This shutter is used to regulate the length of exposition, i.e., the time during which the drops are permitted to enter the trap.

The exposure time depends upon the density of the current, and is set by experiment.

The trap consists of a jigger 25 mm in diameter and 6 mm high. Its bottom is flat and made of optical glass. It is desirable to trap the drops at minimum velocity of descent, as otherwise it is very difficult to catch those smaller than 20 μ in size, while large drops are shattered.

The size of the drops trapped is determined by microscope or photography. The latter is the more reliable and permits a large number of readings to be taken. When water is atomized, it is sometimes dyed black to obtain a precise image, particularly if the drop is less than 10 μ in size. The number of drops trapped must exceed a thousand if the results are to be in sufficiently good agreement for the error not to exceed a few percent.

In the final elaboration of the findings, due allowance must be made for the density of the jet stream at the points where the samplings were taken.

The size of the drops so trapped may be determined by another method as well. If the traps are made deep enough, drop size is determined by rate of precipitation in a liquid medium. This requires that the trap be filled with kerosene if it is water that is to be atomized. Greater precision in the determination of rate of drop precipitation is obtained by projecting the drops on a screen.

In coarse atomization (large drops), drop size is determined by using ordinary blotting paper as the trap. By this method, drop diameter is determined by special calculations based on the size of the blotted trace of the drop.

The dispersed composition of the atomized water is readily determined with the aid of previously-described methods where solid particles are involved, if the drops undergo prior freezing. This is accomplished by means of special traps in which solid carbon dioxide (dry ice) is placed.

Substances with very low temperatures of fusion may be used to study the functioning of atomizing apparatus. When this is done, the particles rapidly cool and solidify. The dispersed composition of these particles is readily determined by one of the methods described.

[Pages 49-89]

CHAPTER IV. THE ATOMIZATION OF SOLUTIONS

The underlying idea in the drying of solutions in atomized form is that the drying process should be almost instantaneous, which requires a marked increase in dispersivity or, what amounts to the same thing, an increase in surface area, and the production of particles of small size. The average drop size in spray drying is usually 20 to 60 μ. Special atomizing equipment is used in the atomization of solutions. Drying engineering knows 3 methods of atomizing solutions: by pressure nozzles, mechanical nozzles, and centrifugal disks rotating at high speed.

The dispersion of solutions requires the outlay of a given amount of energy (a) to create new surfaces, for which the energy

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required is the product of the newly-formed surface per unit time multiplied by the surface tension; (b) to give kinetic energy to the dispersed particles; and (c) to overcome the forces of viscosity.

The loss of energy connected with the overcoming of the forces of viscosity increases with decline in drop size, and may be considerable.

The energy required to form a new surface is, in modern atomizing apparatus, but a fraction of a percent of all the energy expended in atomization.

Atomization by pressure nozzles results from the work performed as the compressed air or steam escapes. In mechanical atomization the energy required (the potential energy of pressure) is transmitted to the solution itself in the form of excess pressure. Atomization by centrifugal disks takes place due to the energy communicated to the solution from a rapidly revolving disk.

In spray drying, the process of dispersing solutions is one of the most important factors governing the economy of this method, quality of product, etc. The greater the dispersion of the spray, the more effective the drying. No less important is the possibility of obtaining a spray of uniform composition, particularly in intensified processes of drying heat-sensitive substances. If atomization is not uniform, the large particles may fail to dry, or the small ones may become excessively dessicated and spoil as a result of the action of heat upon fine particles. In addition, atomizers must meet the following specifications:

(1) maintain a spray of atomized solution of the desired shape;

(2) function reliably;

(3) consume minimum energy in atomization;

(4) atomize viscous solutions or coarse suspensions;

(5) provide high output per unit;

(6) be simple and cheap; and

(7) be easy to service.

Let us examine with an eye to these requirements, the major methods of atomization used in the drying of solutions.

Atomization by Mechanical Nozzles

Various types of mechanical nozzles are used to atomize liquids and solutions. Mechanical nozzles may be divided into 2 groups, by purpose; one is for coarse, and the other for fine atomization. The former are usually employed in scrubber processes, and the latter in sprays or elsewhere. Atomization of solutions for drying is usually at 50 to 200 atm pressure, depending upon the properties of the solution, and the fineness and uniformity of the spray required. Atomization in scrubber processes occurs at a pressure of not more than 4 atm.

Atomization is understood to mean an increase in the surface area of a liquid or solution by causing it to pass from a statically instable to a statically stable state (drops). The statically instable state may consist of drops or threads. By a statically stable form is meant one in which the free energy of the surface of a solution is at a minimum. This occurs only when the drop of solution is spherical. Under all other conditions the free surface energy will be larger, and the drop of solution having an other than spherical shape, will be in a statically instable state.

The mechanism whereby the stream of solution disintegrates

into drops depends upon the conditions and manner of atomization. In mechanical atomization, the manner of drop formation from a solid stream is as follows.

At low rates of emergence from the nozzle, the solution, emitted as a fine stream, begins to decompose into drops at a given distance from the aperture. This is due to the fact that surface tension makes the cylindrical stream statically unstable. Accidental deviations of the diameter of the stream from its average, cause segments of smaller cross-section to come into being. In these areas, the effect of surface tension is to cause pressure to be greater than in those of thicker cross section, with the result that the liquid substance in the thinner segments flows into the thicker, the thinner ones gradually stretch in length and break, forming drops of various sizes.

With increase in the velocity of emission from the nozzle due to increased pressure, the turbulence of the stream increases, and the period of existence of the statically unstable stream shape declines. When emission is turbulent, a radial velocity component is present, so that when the stream is not limited by the walls of the outlet aperture of the jet, the liquid is held together, up to a given point, only by surface tension. The jet decomposes into drops in accordance with the increase in agitation due to the mechanism described above. In this region the decomposition of the stream depends primarily upon the turbulence of the stream emitted from the nozzle. The stream turbulence depends, in turn, upon the rate of outflow of the solution, the size and condition of the exit aperture of the nozzle, etc.

The agitation of the jet of liquid to turbulence increases if it is given a rotatory motion on emergence from the nozzle.

The majority of mechanical nozzles are designed on this principle. Figure 14 illustrates the effect of the rate of rotation (tangential velocity) and the axial velocity of the liquid on the dispersion of the spray in atomization of water with the Grigor'yev nozzle. The drawing shows that when the rate of rotation of the stream of liquid within the nozzle, u'_m is increased from 2.5 to 15 m/sec, while the equivalent axial velocity at the outlet remains the same ($u_э$ = 24.4 m/sec), the mean volumetric-superficial diameter of the drops declines from 63 to 44 μ. Axial velocity has a smaller effect upon the dispersion of the spray (curve 2).

In nozzles with rotatory motion, the liquid forms, at a given rate of emission, a film of solution past the outlet. Under the effect of wavelike fluctuations, this film disintegrates into separate drops. The time during which the film exists depends upon the properties of the solution and the turbulence of the stream. Sometimes nozzles with a rotatory effect upon the stream of solution are called film-formers.

Figure 15 shows the effect of pressure on the length of time the film exists. At a given degree of turbulence, the period of existence of the film is so small that the spray forms as drops at the very mouth of the nozzle. At high rates of outflow the disintegration of the stream is caused not only by the agitation set up on outflow of a turbulent stream but by the pressure due to friction with the environment. After disintegration of the film, further dispersion of the drops just formed may take place under given conditions, as they move at high velocity relative to the medium in which atomization is occurring. In these circumstances, the drop disintegrates due to the pressure of the surrounding medium. As a result of the unequal distribution of the pressure over the

surface of the drop, it undergoes deformation and disintegrates into additional drops under given conditions. The drop will disintegrate if the forces resulting from aerodynamic pressure will exceed those of surface pressure all over the drop. The mechanism whereby the drop disintegrates also depends upon the relative velocity. At high velocities, threads come into being along the edges of the drop, which has been deformed to a disc. These threads disintegrate to form new fine drops.

Thus, depending upon the conditions of atomization, there will be variation in the mechanism of disintegration of the stream into drops. Thus, the composition of the atomized dispersion will depend, in general, on the design of the nozzle, the rate of outflow of solution (pressure), the physical properties of the solution and of the medium (surface tension, viscosity, density). Viscosity affects the disintegration of the stream to a lesser degree than does surface tension. However, in the solutions used in drying procedures, it changes to a much greater degree than does surface tension, so that viscosity does have a marked effect on the dispersion of a spray.

The effect of viscosity consists in the fact that it increases the time required for the stream to disintegrate into drops. As the decomposition of the stream occurs during a period of time in which the conditions of disintegration are changing, the size of the drops formed will vary with the time required for decomposition to occur. If the forces brought to bear to break up the stream or drops decline with increasing distance from the nozzle, an increase in viscosity will mean the production of a coarser spray.

It must be noted that, in drying, the mechanism of disintegration of the stream on atomization is further complicated due

to the presence of the additional process of moisture evaporation, which is accompanied by significant changes in the viscosity of the solution.

Analysis of Mechanical Nozzles

Figure 16 adduces the designs of 2 mechanical nozzles. In one (Figure 16a) the solution is delivered to the chamber, 2, via slots 1, the axis of which is normal to the nozzle axis, but does not intersect it. In both cases, the moment of the quantity of motion of the streams of solution emitted from the nozzle flutings is not zero relative to the axis. Therefore, the solution passes through the chamber of the nozzle, 2, with rotation, i.e., the trajectory of the particles of solution within the nozzle is spiral.

Moving toward the axis of the nozzle, the velocity increases, and the pressure drops to atmospheric. In the mid-section of the nozzle there is an air eddy, 3, with a pressure equal to that of the atmosphere. Therefore the outflow of the solution will take place through an annular section, the internal radius of which will equal the radius of the eddy of air, while the external radius will equal that of the nozzle mouth.

In the center of the stream, and in immediate proximity to the air eddy, velocity will be greatest, as all the potential energy (pressure) is converted into kinetic energy, and the motion is primarily tangential. At points distant from the axis and close to the interior wall of the mouth, the tangential velocity declines, resulting in a residual pressure, which is not completely converted to velocity. At the mouth, where the pressure is generally equal to that of the atmosphere, this residual pressure cannot be sustained any longer and is replaced by a further increase in the axial velocity.

As the jet leaves the nozzle, the effects of centripetal forces from the solid walls cease, and the particles composing the solution fly off in all directions, forming the plume of spray.

If losses due to viscosity in the nozzle be left out of consideration, the quantity of solution emitted per second will be proportional to the square root of the total pressure head in the direction of discharge, i.e.

$$G = \mu F_c \sqrt{\frac{2g\,\Delta p}{\rho_p}} \text{ м}^3/\text{сек}, \qquad \text{(IV-1)}$$

in which F_c is the cross-sectional area of the nozzle mouth, in m^2

Δp is the total pressure head in kg/m^2

ρp is the specific gravity of the solution in kg/m^3

g is the acceleration of gravity, 9.81 m/sec^2, and

μ is the efficiency of the nozzle.

The efficiency of the nozzle varies within broad limits (from 0.1 to 0.9) depending upon the viscosity of the solution and the efficiency of the open cross-section of the mouth, which in its turn is governed by the radius of the eddy of air. Experimental data show that the ratio of the air eddy radius to that of the nozzle mouth remains almost constant for nozzles of given type and dimensions within broad limits of change in pressure.

For nozzles with large mouth cross-section, this ratio is 0.6 to 0.8, while for small mouth cross-sections it is 0.3. As solution viscosity rises, the radius of the air eddy declines, all other conditions being equal.

Taking the quantity of motion of any particle of a solution relative to the axis of the nozzle to be a constant, in the absence of friction, G. N. Abramovich (1), considering a centrifugal nozzle

with one intake aperture, found the following relationship between efficiency of output, μ , and free cross-section, ϕ :

$$\mu = \frac{1}{\sqrt{\frac{1}{\varphi^2} + \frac{A^2}{1-\varphi}}}. \qquad \text{(IV-2)}$$

The coefficient for the free cross-section of the nozzle, ϕ , indicates the degree to which the nipple is filled, and depends upon the geometric characteristic of the nozzle, A, and the viscosity of the solution:

$$\varphi = 1 - \left(\frac{r_m}{r_o}\right)^2 = \left(\frac{u_э}{u_o}\right), \qquad \text{(IV-3)}$$

in which r_m is the radius of the air eddy;

r_o is the radius of the nozzle mouth;

$u_э$ is the equivalent velocity, equal to the ratio of the discharge of solution per second to the cross-sectional area of the mouth; and u_o is the discharge (axial) velocity of the solution in the output cross section.

The geometrical characteristic is determined by the dimensions and the design of the nozzle (see Figure 16), and is

$$A = \frac{\pi R_{ex} r_o}{nf} \cos \psi, \qquad \text{(IV-4)}$$

in which R_{ex} is the distance from the axis of the input aperture to the axis of the nozzle, in meters;

n is the number of input slots,

f is the area of the input aperture of the slot, in m^2;

ψ is the angle between the axis of the incoming stream of solution in the slot, and the plane perpendicular to the nozzle axis, in degrees.

For friction-free flow of solution in the nozzle, the relationship between the coefficient of the outflow and the nozzle characteristic

is expressed by the following formula:

$$A = \frac{1-\varphi}{\sqrt{\frac{\varphi^3}{2}}}. \qquad \text{(IV-5)}$$

The angle of the tongue of spray depends upon the relationship between the tangential and axial velocities of the particles of solution at the nozzle outlet, and comes to

$$\operatorname{tg}\Theta = \frac{u_m^{cp}}{u_0} \approx \frac{\sqrt{8}(1-\varphi)}{(1+\sqrt{1-\varphi})\sqrt{\varphi}}, \qquad \text{(IV-6)}$$

in which u_m^{av} is the mean tangential velocity in the input aperture of the nozzle.

The coefficient of discharge calculated on the theoretical expressions (IV-2) and (IV-5) is somewhat less than in reality, particularly for viscous solutions. However, it makes it easy to follow change in the spray characteristic resulting from variations in the geometrical dimensions of nozzles, and the results are in good agreement with experimental data. The coefficient of discharge of the nozzle increases with the increase in the angle, ψ, and the number of input slots in the nozzle, and declines with increase in the radius of the rotating chamber, R_{bx}, and the output aperture r_0, while the angle of spray varies in the opposite manner. Consequently, by making the appropriate changes in nozzle dimensions, we are able to obtain the desired configuration of the tongue of spray, and the desired output.

The power expended in atomization by mechanical nozzles is

$$N = \frac{GH\gamma_p}{102\,\eta_н}\ \text{кВт}, \qquad \text{(IV-7)}$$

in which H is the full pressure head in mm/Hg;

G is the discharge of solution per second, in m^3/sec; and

$\eta_н$ is the pump efficiency.

Figure 17 adduces mechanical nozzles of various designs, in which the solution is delivered through slots at various fixed angles to the nozzle axis and the horizontal. The Kerting nozzle (Figure 17a) consists of a housing 1, and an insertion piece, 2. The solution is given rotatory motion by passage through the channels 3, formed by the cutting of threads in the insert. The thread is made in 2 or 6 turns. The channels are 1 or 1.2 mm in cross section.

Figure 18a adduces the discharge efficiency of this nozzle when atomizing water at 0.5 to 4.5 atm excess pressure. The drawing shows that the discharge efficiency, μ , declines with increase in the diameter of the output aperture of the nozzle. The coefficient of discharge undergoes practically no change with pressure, Δp in nozzles of identical design and dimensions, although, as is evident from Figure 18b, there is a tendency to decline at low pressures.

The Grigor'yev nozzle (Figure 17b) consists of a housing, 1; a cover, 2; and a washer, 3. Inside the nozzle there is a cone, 4, carrying triangular slots, 5, tangential to the inside circumference. Moving along these slots, the solution acquires a tangential component for its velocity, and a new component for its motion at discharge. There may be from 2 to 6 slots, the section of each being from 0.5 to 0.6 mm^2. The discharge efficiency of this nozzle, with mouth diameters of 0.66 and 1.45 mm, when used to atomize water, is adduced in Figure 18b.

Figure 17c shows the design of a nozzle analogous to the Grigor'yev nozzle in design. Figure 19 adduces the relationship of the discharge efficiency of a nozzle with a mouth 0.785 mm in

diameter to the tangential component of the velocity of the stream of liquid entering the eddy chamber. As may be seen in Figure 19, the discharge efficiency declines from 0.54 to 0.22 with rising tangential velocity. As this occurs the average volumetric-superficial diameter also declines, from 62 to 43 μ. The angle of emission of the spray changes from 40 to 80° in accordance with the axial and tangential components of the velocity of the liquid at output from the nozzle.

The TsKKB nozzle (Figure 20a) consists of a casing and 3 disks seated flush on each other. Disk 1 is the distributor ring, the solution moves to 3 feed chambers in the second disk, 2, from which, via tangential canals, it moves to the eddy chamber in the center of this disk. The stream, now given rotatory motion, passes through the mouth of the nozzle, which is cut into disk 3. This nozzle is widely used to atomize fuel oil.

Another TsKKB nozzle (Figure 20b) consists of a casing, 1, and 2 inserts. The solution passes through 6 apertures in insert 2 to reach a distributor channel, from which tangential slots lead to the eddy chamber.

The slots are usually of circular or rectangular section. The number of slots varies from 2 to 4. From the chamber, the solution proceeds to the nozzle mouth drilled in insert 3. The angle of the conical portion of the mouth is 90°. These nozzles are built to deliver 6 to 6,000 kg/hr, with a spray tongue angle of up to 150°.

In Figure 21 we adduce the relationship between the discharge efficiency of the nozzle and the geometric characteristic, A, for atomization of water. The chamber diameter was 20 mm, the number

of channels from 2 to 4, the slot diameters 1.6 to 6.3 m, and the diameter of the mouth was 1.6 to 7.0 mm. The drawing also shows, by the broken line, the dependence of upon A, in accordance with theoretical equation (IV-2). Figure 21 shows that the theoretical value of the coefficient of discharge is in good agreement with the experimental data, when A is up to 2.0. When A is larger than this, the theoretical discharge efficiency of the nozzle is smaller than that obtained by experiment.

Figure 20c illustrates a low-output nozzle (50 to 200 kg/hr) operating at pressures of 30 to 150 kg/cm^2. It consists of a casing, 1, a bushing, 2, and inserts, 3. Two tangential slots, 4, have been drilled in the bushing. The solution passes through them to the eddy chamber and then to the nozzle mouth.

Centrifugal nozzles, one of which is shown in Figure 22, are often used when a coarse spray is desired. This nozzle produces an umbrellashaped jet stream, and is often used to spray water in conditioners. Figure 23 shows nozzles of various designs used for coarse atomization of solutions contaminated with foreign matter. The VTI [Vsesoyuznyy Teplotekhnicheskiy institut -- All-Union Heat-Engineering Institute] nozzle with impact action (Figure 23a) is insensitive to impure solutions. With these nozzles, atomization occurs outside the body of the nozzle, as a result of the impact of the stream of solution against an atomizer mounted opposite the mouth. The resultant spray is very far from uniform. To prevent rapid wearing out of the rib on which the conical cap is mounted, the VTI (Figure 23b) causes disintegration into drops by collision between 2 streams emerging from mouths (channels) in the nozzle casing.

The nozzles below (Figures 23c and d) are used in the

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atomization of a large variety of solutions for which coarse dispersion is the object. When the nozzle whose dimensions are shown in Figure 23b is used to atomize water, the discharge coefficient, μ is 0.25.

As previously noted, the dispersion of the spray depends upon the conditions of atomization, the physical properties of the solution, and the medium in which atomization occurs.

For the atomization of low-viscosity liquids and for cases in which the pressure on a drop of the medium is the controlling factor in dispersion, the maximum diameter of the drops in the spray (δ_{max}) may be determined on the formula

$$\delta_{max} = K \frac{8 \cdot \sigma g}{\rho_s u^2} \text{ м}, \qquad \text{(IV-8)}$$

in which σ is the surface tension in kg/m;

ρ_c is the specific gravity of the medium in kg/m;

u is the discharge velocity of the stream, in m/sec;

and K is a coefficient depending upon the properties of the liquid.

The following values may be used for K;

Water K = 2.5 (σ = 0.00745 kg/m)

Alcohol K = 3.5 (σ = 0.0023 kg/m)

Glycerine K = 5.0 (σ = 0.0065 kg/m)

When solutions are atomized by means of the Grigor'yev nozzle (Figure 17c), the average volumetric-superficial diameter may be calculated on the following empirical equation:

$$\delta_{3,2} = 11{,}3\,(\delta_o + 4{,}32)\, e^{\left(\frac{3{,}86}{u_э} - 0{,}0308\, u'_m\right)} \; \mu \qquad \text{(IV-9)}$$

in which δ_0 is the diameter of the nozzle mouth, in mm;

$u_э$ is the equivalent axial velocity of the discharge stream, in m/sec; and

u'_m is the tangential component of the velocity of the stream of solution at the eddy chamber intake, in m/sec

Equation IV-9 is valid within the following limiting values of the variables

$_0$ = 0.34 - 1.1 mm, $u_э$ = 12 - 50 m/sec, u'_m = 2 - 16 m/sec

Advantages and Shortcomings of Mechanical Atomization

Atomization by mechanical nozzles enjoys the following advantages:

(a) mechanical nozzles are very simple, compact, and noiseless;

(b) they require little power, consuming only 4 to 10 kw/t of solution, depending upon the physical properties of the solution and the desired degree of dispersion,

(c) the desired configuration of the spray may readily be attained by adjustment of the interior nozzle design, and

(d) their output is high; a single nozzle can atomize up to 4,500 kg of solution per hour at the desired degree of dispersion.

On the other hand, mechanical nozzles display a number of shortcomings, viz.:

(a) it is practically impossible to adjust the rate of discharge while atomization is in progress. The reason is that the rate of discharge is governed by the cross section at the mouth, and by pressure. Therefore, if a valve ahead of the nozzle is used

to control discharge, the pressure in the atomizer drops sharply, resulting in a marked decline in the dispersion of the spray. Adjustment is therefore possible only by replacement by nozzles of different dimensions;

(b) the small dimensions of the mouth (0.5 to 1.0 mm), which make mechanical nozzles sensitive to the presence of foreign materials in the solutions, which rapidly foul the mouth;

(c) mechanical nozzles cannot be used to atomize pasty solutions and suspensions in which the surface of separation between the phases is solid, as this rapidly fouls them as the result of deposition of the solid phase in the slots; and

(d) the nozzle mouth undergoes erosion, thus affecting the nozzle discharge rate. Nozzles with larger mouths are less subject to erosion.

Atomization by Pressure Nozzles

Pressure nozzles of various designs are also used in atomization. They may be classified as low-pressure and high-pressure nozzles, or as nozzles with external and internal blending. Low-pressure nozzles are not generally employed in spray drying. Steam or compressed air may be used. No essential difference in nozzle design is required.

Figure 24a adduces a schematic of an internal-blending pressure nozzle. Compressed air enters via the whirler, 1. The solution is delivered to the space between the tubes, 2. The high velocity at which the air and solution are discharged causes the latter to undergo atomization in the blending chamber, 3, and the blend of suspended particles of solution and air escapes through

the outlet. This type of nozzle operates at critical discharge velocities.

Sometimes this type is designed with an expanding nozzle (Figure 24b). The velocity of the air or steam on discharge from the expanding portion is above the critical point, and this results in high dispersion of the solution. However, internal-blending nozzles have not come into wide use in drying processes, as they often clog by formation of clumps and beards of particles dried out of solution.

Externally-blending pressure nozzles are distinguished by the fact that the dispersion of the solution takes place outside the nozzle casing. This facilitates reliable and consistent functioning of the nozzles when used to atomize solutions varying in their physical properties.

A pressure nozzle with external blending and axial delivery (Figure 25a) consists of a case, 1, and insert, 2, through which the solution is delivered, and a tip, 3. The compressed air is delivered radially. Nozzles of this type produce long, narrow sprays.

At present the pressure nozzle shown in Figure 25b is in wider use. As distinct from the preceding design, the compressed air is delivered to this nozzle tangentially, which causes it to rotate. The rate of rotation rises as the mouth is approached, and depends upon the taper of the nozzle.

The conical vortex of air, rotating at high speed, has its vertex outside the nozzle. This vertex is, at the same time, that of the cone of spray. Thanks to the high rate of rotation the spray is short and broad, this being particularly important in

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spray drying. The discharge capacity of this nozzle is 120 to 150 kg of solution per hour. Air under 4 to 7 atm pressure is employed in atomization. The discharge of air is 0.4 to 0.8 nm^3 per kg of solution, depending upon its physical properties and the discharge rate of the nozzle. The greater the discharge per nozzle, the larger is the proportion of air in the mixture required to maintain a uniform spray. These nozzles are of high injection capacity. At 5.0 atm pressure the maximum vacuum in the solution delivery line is 4.0 to 4.5 meters water column. Proper setting of the insert, 2, is determined in accordance with the maximum vacuum in the solution delivery line. The insert is fixed in the optimum position by rings, 6, of varying thickness. The point of intake is 100 mm above the mouth. The annular output aperture is of particular importance in nozzles with tangential air intake. Only if the compressed air is emitted in proper annular form, to the same distance all around the aperture, is high rotational velocity obtained and, consequently, good atomization.

The delivery of solution to the nozzle is usually accomplished by the vacuum set up by the nozzle itself. A uniform rate of delivery makes it necessary for a constant level of solution to be maintained in the feed container. Figure 26 shows the manner in which the nozzle is fed with solution. The discharge rate of the nozzle may be changed by reducing the delivery of solution by using an insert with a channel of different cross section. The taper of the spray may be varied by changing the dimensions of the nozzle. The maximum diameter of the spray that can be set up by the nozzle shown in Figure 25b is 1.4 to 1.7 m, at 4.0 atm excess pressure.

Atomization by axial-delivery pressure nozzles with external

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mixing results in a marked decline in the uniformity of the spray as rate of discharge increases. Therefore, these nozzles are normally employed when drying is with gases at low temperature, and discharge is up to 150 kg/hr. At high drying temperatures (400 to 600°C), the discharge capacity per nozzle may be up to 650 kg/hr.

Figure 27 presents a drawing of a pressure nozzle which delivers 650 kg/hr. Steam at 4 atm excess pressure is used for atomization. The steam consumption is 0.45 to 0.5 kg per kilogram of solution. The maximum diameter of the spray is 2.2 m.

The use of steam to atomize solutions is more economical than use of compressed air. However, steam may be used to atomize solutions only if they are dried in media with high gas temperatures (300°C minimum ahead of the drier) so as to set up a moisture evaporation process of adequate efficiency. In addition, it is desirable to use superheated steam for atomization, as saturated steam would condense, in part, under adiabatic conditions of outflow from the nozzle.

To obtain a high rate of discharge from an external-blending pressure nozzle, with a satisfactory degree of dispersion, the thickness of the film of solution at the nozzle exit must be reduced. To accomplish this, the solution is delivered to an annular space in the nozzle, where it forms a sort of hollow cylinder. The compressed air is delivered to the center of this cylinder. The design of such a nozzle is shown in Figure 28. Its capacity is 2,000 kg/hr. The consumption of compressed air is 0.75 nm^3 per kilogram of solution at 4.0 atm excess pressure. The resultant vacuum in the liquid supply line may reach 3.0 m water column. The suction intake is 100 mm from the mouth. The spray is in a horizontal plane and looks like an open umbrella.

Venturi tubes (Figure 29) may be used in atomizing certain solutions. Their operation is distinguished by the fact that air heated to 140°C, and at rather low pressures, is employed in atomization. Atomization may occur at both subcritical and supercritical gas velocities.

Table 6 adduces the characteristics of a Venturi type atomizer when used for liquid sulfur at a density of 1.84 g/cm^3.

TABLE 6

Gas consumption kg/kg	Excess pressure ahead of atomizer	Electricity consumed, kw/t
3.1	0.24	14.9
2.2	0.27	11.6
1.0	0.43	7.8

The average volumetric-superficial diameter of the sulfur drop is, under these conditions, not over 70 μ.

The mechanism of disintegration of the stream into drops with pressure atomization is different from that with mechanical nozzles. In pressure spraying, the air or steam is emitted from the nozzle at high speed, while the rate of emission of the stream of solution is low. At high relative velocity, friction develops between the air and solution streams, with the result that the stream of solution, being contained, as it were, on one side, is drawn out into long individual threads. These threads rapidly separate at points that are thinner than others, and form spherical drops. The length of time during which the statically instable form -- threads -- exists, depends upon the relative velocity of the air and the physical properties of the solution. The greater

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the relative velocity, the thinner the thread, and the shorter the period of its existence. As viscosity increases, the period of existence of the statically-unstable form increases.

This mechanism of disintegration of the stream under pressure atomization is confirmed by experimental data. For example, when viscous products are dried, the dry product is often found to be not a powder, but a matting of individual threads.

This is explained by the fact that when viscous solutions are atomized in media at a high temperature, intensive evaporation results, causing a rapid rise in viscosity, under which the statically-instable form -- threads -- no longer undergoes disintegration. Figure 30 adduces a photomicrograph of dried bone glue obtained by pressure atomization. When the initial moisture content of the solution was 55%, the dry glue was obtained only as threads. Increased moisture resulted in an increase in the amount of dry glue taking spherical form.

In mechanical atomization, all other conditions being identical, the dry glue takes the form of particles spherical in shape (Figure 30d).

The dispersion of the spray depends upon the velocity at which the gas is emitted from the nozzle, the physical properties of the gas and the solution, the geometrical dimensions of the nozzle, and the ratio of the amount of gas to the amount of solution sprayed. This last factor is of particular importance in the spraying of viscous solutions. As the discharge velocity of the steam of compressed air increases, the resultant spray becomes finer. The greater the ratio of compressed air to unit mass of sprayed solution, the more uniform the spray.

Starting from a differential equation describing the conditions for the disintegration of a stream of viscous solution, L. I. Vitman obtained the following expression as a criterion for determining the average drop diameter in a spray:

$$\frac{\delta_{av}}{D} = f\left(\Pi_1, \Pi_2, \Pi_1, \frac{\gamma_g}{\gamma_p}, \frac{L}{G}\right) \qquad \text{(IV-10)}$$

(Equations (IV-10) and (IV-11) are from G. K. Filonenko and P. D. Lebedev, Sushil'nye ustanovki [Drying Equipment], Gosenergoizdat, 1952.)

In the foregoing equation,

γ_g and γ_p are the densities, respectively, of the gas and solution, in kg/m^3;

L and G are the hourly consumption of gas and solution, respectively, in kg/hr;

D is the characteristic size of the nozzle, in meters; and

Π_1 and Π_2 are the determining criteria.

Criterion Π_1 describes the relationship among viscosity, the forces of inertia in the solution, and the surface tension;

$$\Pi_1 = \frac{\nu^2}{\rho_p \sigma D}$$

in which ν is the viscosity in degrees Engler;

σ is the surface tension in kg/m;

ρ_p is the specific gravity of the solution, in kg/m^3.

The criterion Π_2 characterizes the ratio of the forces of inertia in the gas stream to surface tension:

$$\Pi_2 = \frac{\rho_g u^2 D}{\sigma}$$

in which u is the relative velocity of gas and solution, in m/sec;

and ρ_g is the specific weight of the gas in kg/m^3.

The average gravimetric diameter of the drops obtained on the atomization of solutions of low viscosity by internal-blending pressure nozzles may be calculated on the formula

$$\frac{\delta_{av}}{D} = A\pi_2^{-0.45} \qquad \text{(IV-11)}$$

in which the value of A is a function of the criterion, π_1; when

$$\pi_1 < 0.5 \quad A = 0.77 + 1.24\,\pi_1^{0.617}$$

$$\pi_2 > 0.5 \quad A = 0.77 + 0.94\,\pi_1^{0.28}$$

When viscous solutions are atomized by pneumatic nozzles or Venutri tubes, the following empiric equation may be employed to determine the average volumetric-superficial diameter of the drops:

$$\delta_{3.2} = \frac{585}{u} \cdot \frac{\sqrt{\sigma}}{\sqrt{\gamma p}} + 507 \left(\frac{\eta}{\sqrt{\gamma p \sigma}} \right)^{0.45} \left(\frac{1000G}{V} \right)^{1.5} mk \qquad \text{(IV-12)}$$

in which u is the relative velocity of gas to solution, in m/sec;

G and V are the discharge of solution and gas, respectively, in m^3/sec

η is the coefficient of viscosity of the solution, in poises;

σ is the surface tension of the solution in dynes/cm;

γp is the density of the solution, in g/cm^3.

Analysis of Pressure Nozzles

The hydraulic analysis of nozzles consists of determination of the exit cross sections of gas and solution when driven at the designed volume.

Calculation of Exit Cross-section of Gas

In calculating the exit cross section of gas, we consider the flow of gas in the nozzle to be adiabatic, as virtually no exchange of heat with the surrounding medium occurs during the brief period required for the gas particles to pass through the nozzle.

If the ratio of the pressure within the nozzle, p_1, to the pressure of the medium, p_2, into which it discharges, is greater than critical, i.e.,

$$\varepsilon = \frac{p_2}{p_1} > \left(\frac{2}{k+1}\right)^{\frac{k}{k-1}}; \qquad \text{(IV-13)}$$

the velocity in the exit section of the nozzle will be

$$u = \xi \sqrt{2g\,\frac{k}{k-1}\left(1 - \frac{p_2}{p_1}\right)^{\frac{k-1}{k}} p_1 v_1} \ \text{m/sec} \qquad \text{(IV-14)}$$

in which v_1 is the specific volume of the gas in the nozzle, in m^3/kg,

k is the adiabatic index, 1.4 for air, 1.135 for dry saturated steam, and 1.3 for superheated steam; and

ξ is the coefficient of velocity with allowance for friction in the nozzle, or 0.85-0.95.

The flow of gas, L, is

$$L = f \sqrt{2g\,\frac{k}{k-1}\left[\left(\frac{p_2}{p_1}\right) - \left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}}\right]\frac{p_2}{v_1}} \ \text{kg/sec} \qquad \text{(IV-15)}$$

where f is the free cross section at the narrowest point in the nozzle, in m^2.

If the ratio of pressures is less than, or equal to, the critical,

$$\varepsilon = \frac{p_2}{p_1} \leq \left(\frac{2}{k+1}\right)^{\frac{k}{k-1}},$$

the outflow of gas will be at a specific speed, termed the critical speed.

The critical speed, u_{kp}, is:

$$u_{\kappa p} = \sqrt{2g\frac{k}{k+1}p_1 v_1} \text{ m/sec} \qquad \text{(IV-16)}$$

The outflow of gas per second at critical rates of discharge is

$$L_{\kappa p} = f\xi\sqrt{2g\frac{k}{k-1}\left(\frac{2}{k+1}\right)^{\frac{2}{k-1}}\frac{p_1}{v_1}} \text{ kg/sec} \qquad \text{(IV-17)}$$

For air we may write:

$$L'_{\kappa p} = 2{,}145 f\xi p_1 \frac{1}{\sqrt{RT_1}} \text{ kg/sec} \qquad \text{(IV-18)}$$

where T_1 is the absolute temperature of the air, 273 + t°C, and R is the gas constant; for air, R = 29.3 kg-m per kilogram-degree.

The above expressions make it possible to calculate the rate of discharge and the output cross section of the nozzle, with given parameters and gas consumption.

For air, the critical ratio, ξ, is 0.528; for superheated steam it is 0.546, and for dry, saturated steam it is 0.577.

With an expanding nozzle, the exhaust velocity is above the critical. The gas consumption is calculated at the narrowest point, where the speed and flow of the gas will be in accordance with the critical magnitude, if friction be left out of consideration.

Under conditions in which it is important to arrive solely at the average required discharge speed, and the nature of velocity distribution across the exit section is not of high significance, cross sections at intermediate points are left out of consideration, and the contracting and expanding portions are made in conical design, for simplicity of manufacture. To reduce inequalities in the velocity field, the angle at which

the solution moves in the conical expanding segment is set at not over 12°.

In a theoretical study of expanding nozzles, D. P. Kolodnyi (20), concluded that attainment of maximum pressure ahead of the body (of the drops) requires the terminal area of the cone to be 16% larger than the minimum, when air is used, and 21%, when dry saturated steam is used. Under these conditions the pressure on the body is 40 to 45% greater than with a contracting nozzle, the pressure ahead of the nozzle being equal.

Determination of the Solution Discharge Aperture

The solution discharge aperture is calculated on the formula:

$$f_0 = \frac{G}{u} \text{ м}^2, \qquad \text{(IV-19)}$$

in which G is the discharge of solution, in m^3/sec, and u is the discharge velocity, in m/sec.

The velocity of discharge at given head, Δp kg/m^2, (in millimeters of water column), may be found by the formula

$$u = \mu \sqrt{\frac{2g\,\Delta p}{\rho_p}} \text{ m/sec} \qquad \text{(IV-20)}$$

in which Δp is the total head, in kg/m^2;

ρ_p is the specific gravity of the solution, in kg/m^3, and

μ is the coefficient of discharge.

For nozzles with external mixing the full head is equal to the [illegible] of the pressure ahead of the nozzle, and the vacuum at the point [illegible] the solution emerges from the nozzle. When solutions [illegible] by the vacuum created by the nozzle itself, it is [illegible] to write into equation (IV-20) the magnitude of the equation, [illegible] loss of pressure to friction in the line.

The coefficient of discharge varies widely (from 0.2 to 0.7) and is dependent upon the conditions under which the outflow of solution occurs. This is determined by the Reynolds number (Re), i.e., the ratio of the forces of inertia to the viscosity.

The Reynolds number (a dimensionless magnitude) is

$$\mathrm{Re} = \frac{u\,\delta_{om}}{\nu}, \qquad \text{(IV-21)}$$

where ν is the kinematic viscosity of the solution in m^2/sec, and δ_{om} is the characteristic dimension (when the liquid is discharged from a round aperture, the diameter of the hole; when through an annular aperture, the width of the ring), in meters.

At low Reynolds numbers ($\mathrm{Re} \lesssim 2$), when the effect of the forces of inertia is negligible relative to the viscosity, the coefficient of discharge, according to A.D. Al'shtul', (2), is

$$\mu = \sqrt{\frac{\mathrm{Re}}{48}}; \qquad \text{(IV-22)}$$

in which $\mathrm{Re} \approx 50$ $\mu = 0.21$, $\mathrm{Re} > 300{,}000$ $\mu = 0.6$. The maximum values of μ is about 0.7, when Re is 200 to 400.

Loss of head to friction in luminal motion in pipes, i.e., when $\mathrm{Re} < 1200$, may be calculated on Poiseuille's equation:

$$H_{mp} = \frac{32\,\nu\, l u}{g\,\delta^2}, \qquad \text{(IV-23)}$$

in which l is the tube length, in meters, and δ is the pipe-line diameter, in meters.

The cross-sections of the air and steam lines are usually calculated for a transit velocity of 10 to 20 m/sec, and that of the solution line on a velocity of 0.25 to one m/sec.

Power Consumption

The electric power required to atomize with compressed air may be calculated by the usual formulas used to calculate the power needed by centrifigal or piston compressors.

The power required by a turbine pump and its cooling equipment, is

$$N = 3{,}88 \frac{V_{в}}{\eta_0 \eta_м \eta_и} \cdot \frac{T_0}{273} \cdot \lg \frac{p}{p_0} \qquad \text{(IV-24)}$$

in which V_B is the air delivered, in nm^3/min, at 760 mm/Hg and 0°C,

p_0 is the air pressure at the intake, in atmospheres,

T_0 is the absolute air temperature at the intake of the machine, or 273 + t °C,

p is the terminal air pressure in atmospheres,

η_0, η_m are, respectively, the volumetric and mechanical efficiencies, taken as 0.97 to 0.98, and

η_u is the isothermic efficiency, or 0.55-0.65.

Advantages and Disadvantages of Pressure Atomization

Pressure nozzles permit atomization of solutions of virtually any degree of viscosity. Pressure nozzles are reliable, and simple in design. The shape of the spray may be adjusted easily in any desired direction.

The disadvantages of this method are, primarily, the large power consumption (50 to 60 kw/t of solution) and the difficulty in obtaining a satisfactory spray simultaneous with high output per nozzle. Therefore, when circumstances require the atomization of a large amount of solution, it is necessary to mount as many as 35 nozzles in a single drying chamber.

The spray itself is less uniform than that produced by other methods. This is due to the unequal distribution of the energy of the compressed air or steam through the cross section of the stream of solution.

When pressure spraying operates on compressed air, additional personnel is required for the operation of the compressor installation.

Atomization by Centrifugal Disk

Atomization by centrifugal disk has come into wide use, thanks to certain special advantages. This method differs from atomization by mechanical nozzles in that the solution acquires high velocity without application of pressure.

Through an intake funnel (Figure 31), the solution strikes a rotating disk, which imparts rotatory motion. Centrifugal forces cause the solution to be displaced in the form of a film with constantly increasing velocity, to the periphery of the disk where it is thrown off. The atomization of the solution occurs at this point.

The mechanism of atomization depends upon the conditions of operation of the centrifugal disk. At low discharge velocities and volumes, atomization proceeds by direct formation of drops. The film of liquid flows to the edges of the disk and takes the form of a suspended cylinder. The cylinder increases in size until a critical value of velocity and volume is reached. At this point, the liquid film becomes convex along the periphery of the disk, and under the influence of centrifugal force, overcoming surface forces tending to hold the solution to the solid surface, undergoes

disintegration. As rate of flow is increased, individual fine streams are formed, which, being statically unstable, dissipate into drops. Further rise in rate of flow results in the stream being converted to a solid film, which also comes apart, with formation of individual drops. The disintegration of the individual streams or films of solution takes place at some distance from the disk. As the velocity of the current of solution increases, the disintegration of the statically unstable forms sets in earlier. As with atomization by mechanical nozzles, the disintegration of the statically unstable form is due to the turbulence of the current and the forces exercising pressure on the surface of the solution, due to friction with the air.

In the former case, disintegration results from the interaction of the internal velocity gradiant and service tension, and the force of the mass, without the external pressure of the air exercising any effect. The presence of this disintegration mechanism is confirmed by experimental data (atomization of solutions in vacuum). In this case, the drop size in inversely proportional to the square root of the centrifugal force, or the peripheral velocity to the first power.

When a film or stream of solution disintegrates, due to pressure resulting from friction with the air, drops are formed from fine threads, as in atomization by pneumatic nozzles. This mechanism of atomization is also confirmed by experimental data, in which the dried product obtained by drying viscous solutions under specific conditions of disk operation is in the form of a matting of individual fine fibers. When the stream disintegrates due to friction with air, the drop size must be inversely proportional to the square of the peripheral velocity. Thus, in

atomization by centrifugal disks, there can be no question that both mechanisms of disintegration of the stream into drops occurs. If the former mechanism of stream disintegration predominates, the spray will be more uniform.

The lack of uniformity of the spray in general is explained primarily by the fact that the disintegration of the individual streams of film occurs at different distances from the disk, i.e., disintegration occurs in the film at various thicknesses. The lack of homogeneity of the solution rises, with transition from the stage of disintegration of individual streams, to disintegration of the film. Thus, drop size and the homogeneity of the spray are dependent upon the peripheral velocity of the disk and the thickness of the film of solution, and this in turn is governed by rate of flow.

When peripheral velocity is below 50 m/sec, the spray is very heterogeneous. It consists, as it were, of a major group of large drops, and a group of small drops which deposit closer to the disk. As the rate of rotation increases, uniformity increases, the distance between the bulk of the large and small drops becoming smaller. From 60 m/sec, and upward, this type of classification does not occur, so that that rate may be taken as the minimum for industrial use.

The uniformity of the spray rises with reduction in disk vibration, constancy of delivery of solution, and smoothness of disk surface.

Thus, the dispersion of the spray is governed by the peripheral velocity of the disk, the rate of flow of solution per wetted perimeter, the physical properties of the solution, etc. The mean

diameter of the drop, as a measure of the general dispersion, will depend upon the factors listed above, and, to varying degrees, upon the mechanism of stream disintegration.

On the basis of a large number of experiments with nine different disks, A. I. Lastovtsev (26) derived an empirical ratio for the determination of the mean volumetric-superficial drop diameter ($\delta_{3.2}$), viz.:

$$\delta_{3,2} = 81 \frac{\sigma^{0.46} b^{0.46} \eta^{0.08}}{u \rho_p^{0.54}} \text{ мк}, \qquad \text{(IV-25)}$$

in which b is the size of the streams or film, in meters.

Expression IV-25 was obtained by varying the variables: velocity, u, from 20 to 180 m/sec; flow of solution, G, from 10 to 1,200 lit/hr; surface tension, σ, from 28 to 81 dynes per centimeter; the specific gravity of the solution, ρ_p, from 0.85 to 1.7 g/m3; and viscosity, η, from 1 to 600 centipoises.

Under certain conditions it is of greater interest to know not the average, but the maximum drop size. According to literature data (49), the maximum size of drops formed on atomization by centrifugal disks, is

$$\frac{\delta_{max}}{R} = 0{,}365 \left(\frac{G}{\gamma_p n R^2}\right)^{0,6} \left(\frac{\eta}{G}\right)^{0,2} \left(\frac{\gamma_p \sigma l}{G^2}\right)^{0,1} \text{ м}, \qquad \text{(IV-26)}$$

in which R is the disk radius, in meters.

This expression was derived by a process of varying the variables, as follows: rate of flow, G, from 0.003 to 0.5 kg/sec; revolutions per minute, n, from 14 to 300 per second; wetted perimeter, l, from 0.008 to 0.48 m; density of solution, γ p, from 1,000 to 1,400 kg/m3; disk radius, R, from 0.01 to 0.1 m; and viscosity, η, from 1 to 9,000 centipoises.

Experimental findings reveal that the dispersion of the spray is virtually independent of disk design, if the conditions of operation are the same.

Analysis of Centrifugal Disks

Flow of Solution onto the Disk

On striking the disk, the solution acquires a certain rotary velocity, due to the friction between it and the disk surface. Centrifugal forces applied to the solution compel it to move toward the disk edge. As a consequence, each elementary particle in the solution has 2 factors in its velocity vector: one radial, the other tangential to the perimeter. If the disk is solid, the particles of solution are displaced to the disk edge, by sliding, in a path which curves relative to its surface. If the solution is moving through the disk slots (see Figure 31), the rate of slip may be ignored, and the rate of rotation of the solution will equal the peripheral velocity of the disk. When the solution moves without friction, the radial velocity will also equal the peripheral velocity of the disk, ωr, when ω is the angular velocity of the disk, and r is the radial distance from the axis of rotation. Consequently, the maximum possible velocity of the solution, u_{max}, on disengagement from the disk, will be

$$u_{max} = \sqrt{2}\,\omega R, \qquad \text{(IV-27)}$$

in which R is the disk radius, and the angle between the velocity of disengagement vector and the peripheral-velocity vector, designated as θ is 45°.

However, owing to friction, the radial velocity of the solution will be less; therefore, the angle θ will be less than 45°.

If we omit the effect of gravity, a differential equation may be written, composed of the balance of forces acting on a particle of solution, for the motion of the solution in an atomizer with radial slots:

$$u_r \frac{du_r}{dr} + A u_r^{2{,}5} - \omega^2 r = 0, \qquad \text{(IV-28)}$$

in which u_r is the average radial velocity of the solution, at a radial distance, r, from the axis, in m/sec, ω is the angular velocity of rotation of the disk in 1/sec, and A is the coefficient.

The coefficient, A, follows from the effect of friction on the motion of the solution in the disk slots, and is variable. It depends upon the conditions of flow and the effective velocity gradient across the film of solution. The motion of the solution in ~~the disk slot~~ varies ~~from~~ laminary ~~to~~ turbulent. Under these conditions, it is difficult, lacking appropriate experimental data, to determine the dependence of A on conditions of flow. For this reason, equation (IV-28) is not solved in its general form.

If A be taken to be a constant, within given limits of variation of the variables, it is not difficult to solve equation (IV-28).

An approximated solution for the radial velocity of the solution, u_r, at the moment of disengagement from the disk, has been offered by A. M. Lastovtsev (26). It reads as follows:

$$u_r = \frac{\omega^{0{,}8} R^{0{,}4}}{A^{0{,}4}} \left(1 - \frac{0{,}35}{A^{0{,}95} \omega^{0{,}42} R^{1{,}43}}\right)^{0{,}4}. \qquad \text{(IV-29)}$$

According to A. M. Lastovtsev's experimental findings, the coefficient A, is:

for channels of circular section:

$$A = 0{,}09 \frac{r_\kappa^{0,35}\, \nu^{0,25}}{\left(\frac{G}{n}\right)^{0,8}};$$

and for channels of rectangular section

$$A = 0{,}105 \frac{b^{0,35}\, \nu^{0,25}}{\left(\frac{G}{n}\right)^{0,8}},$$

in which r_k is the channel radius, in meters, ν is the kinematic viscosity of the solution, in m^2/sec; b is the height of the channel, in meters; n is the number of channels; and G is the rate of discharge of the disk, in m^3/sec.

Depending upon the value of A, the radial velocity is 0.3 to 0.85 of the theoretical velocity, ωR, the effect of A rising as the solution moves on the disc from the initial point of contact. If the distance, r_0, from the point of contact of the solution with the disk, to the axis of rotation, is 40 mm or less, it is virtually without effect on the final radial velocity of the solution, u_r.

The velocity of the solution on disengagement of a vane disk is

$$u = \sqrt{\omega^2 R^2 + u_r^2} \quad m/sec \qquad \text{(IV-30)}$$

If the current of solution be assumed not to disintegrate, we may calculate the thickness of the film of solution at any point.

In the general case, the cross-sectional area of the film of solution, f_{pl}, will be

$$f_{пл} = \frac{G}{n u_r} \text{ м}^2, \qquad \text{(IV-31)}$$

in which n is the number of vanes.

The thickness of the film of solution for a disk with radial vanes is

$$h = \frac{f_{nA}}{b} \text{ M},\qquad \text{(IV-32)}$$

in which b is the vane height, in meters.

The Stream of Spray

The shape of the spray, and its diameter, are of great importance in determining the diameter of a spray drier. The diameter of the stream is of particular importance in atomization with centrifugal disks. In atomization with mechanical or pressure nozzles, spray stream diameter is not of such fundamental importance, as it is readily subject to change as desired by slight variations in nozzle dimensions. In this case, the spray stream diameter is always capable of adjustment so as to prevent the drops from striking the walls of the drying chamber before they are dry. However, in atomizing with centrifugal disks, it is difficult to produce significant changes in the diameter of the spray stream by changing disk design, all other conditions being equal. Therefore, lacking precise data on the spray stream, it is difficult to determine correctly the required diameter of the drying chamber. Thus, if the drying chamber diameter is somewhat larger than the spray stream diameter, the volume of the drier will not be efficiently employed. On the other hand, if the diameter is reduced, the solution will strike the walls, and this results in spoilage of some of the product.

In atomization by centrifugal disks, the spray stream is in the horizontal plane. The diameter of the spray is determined by

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the distance of flight of the drops of solution. Usually, the circle within which 90 to 95% of all the atomized solution precipitates is taken as the diameter of the spray. Small drops lose their initial velocity more rapidly, due to friction with the air. Consequently, the larger the drop size, and the less uniform the spray, the greater will be the diameter of the spray. As previously noted, the dispersion of the spray depends primarily on the velocity and thickness of the film of solution upon disengagement from the disc. Therefore, as disc output increases, all other conditions being equal, spray diameter rises. On the other hand, as the rate of rotation of the disk increases, the diameter decreases. On Figure 32, we adduce a graph showing the distribution of the spray current, by weight, with disks 6 and 7 in Figure 35, in accordance with the rate of output and the peripheral speed of the disk. Figure 32b shows that, with increase in peripheral velocity, there is an increase in the radial distance from the axis of rotation of the disk to the point at which 90% of all the atomized solution precipitates. A maximum is attained at ωR of 15 m/sec, the distance decreasing as ωR increases over this value. An analogous picture may be seen for distribution of 50% of the solution spray.

It must be noted that, in atomization by centrifugal disks, it is difficult to obtain any marked variation in the density of the stream of drops in suspension per square meter of drier area without affecting the dispersion of the spray. This is explained by the fact that when the spray is in the horizontal plane, its diameter rises with rising quantity of discharge. Therefore, when this is great, multiple disks are used to produce good dispersion, reduce spray diameter, and thereby raise the density of the current of solution per unit area of drier.

The distribution of the density of the current of solution across the spray diameter is governed by many factors. By density, we mean the hourly quantity of solution, in kg/hr, per square meter of horizontal surface ($kg/m^2/hr$).

At peripheral velocities of more than 60m/hr, the density of the current rises with distance from the disk, attaining a maximum at a given distance therefrom, after which it declines.

At lower peripheral velocities we observe a number of maximums due to the inhomogeneity of the spray. The distance from the disk axis to the point of maximum current density declines as the dispersion of the spray increases. However, the maximum density of the current rises as a more uniform spray is obtained.

The distribution of current density and spray diameter is greatly affected by air circulation during atomization by centrifugal disks. Air circulation results from the friction between disk surface and air, the disengagement of solution from disk, and its mixing with the air, and to the effect of the rotating disk as an air pump. In the latter case, the air, with disks of certain designs, is sucked in at the points of intake of the solution, and ejected through the exit apertures. This produces an increase in the drop flight distance, while the dispersion of the spray remains unchanged. Small drops are readily taken up by the current of air, and borne off to the periphery.

With this kind of circulation, there is, as shall be indicated below, an increase in power consumption for atomization. In addition, when air is sucked onto the disk, the possibility arises that dry particles may also strike it. This may foul or unbalance the disk. Special shields, such as are shown in Figure 31, are provided to prevent this from happening.

The phenomenon of circulation in atomization by disk may also explain the fact that no sharp classification of the spray into fractions occurs, and that the composition of the spray dispersion, following the radius out from the axis, shows insignificant change.

Consumption of Energy

The energy consumed on atomization by disk is composed of that required to communicate kinetic energy to the solution being sprayed, N_k, that used in overcoming friction between the disk surface and the air, N_m, and that required for circulation of the air past the disk, N_y, so that

$$N = N_k + N_m + N_y \qquad \text{(IV-33)}$$

The expenditure of energy on air circulation depends on disk design, and increases with rise in rate of rotation. For disks with radial vanes, or lacking vanes, the amount of air passing across the disk is insignificant. On the other hand, for discs with curved vanes, the amount of circulating air is considerable, and depends upon the direction in which the disk rotates. Figure 33 shows the effect of air circulation across the disk on energy consumption. Special devices are sometimes provided to prevent this circulation from taking place.

The consumption of energy in communication kinetic energy to the solution is readily calculated if we know the velocity at which it leaves the disk. If this velocity is $u_{max} = \sqrt{2}\omega R$, this maximum consumption of energy will be:

$$N_k = 1{,}095 \cdot 10^{-8}\, G n^2 \left(R^2 - \tfrac{1}{2} r_0^2\right) \text{ кВт}, \qquad \text{(IV-34)}$$

in which G is the capacity of the disk, measured in kilograms of solution per hour, r_0 is the radial distance from the axis to the

point at which solution contacts the disk, in meters, and n is the number of revolutions made by the disk per second.

Experimental data on the expenditure of electrical energy (47) are in good agreement with equation (IV-34), although a little lower than the results thus obtained (Figure 34). This is explained by the fact that the solution slips across the surface of disk models lacking vanes or channels.

The energy consumed in overcoming the friction between the air and the disk surface is small, with disk diameters of under 200 mm, and rates of rotation up to 250 revolutions per second.

The losses to friction, N_m, may be calculated from the empirical formula of Stodol commonly used to calculate loss to friction, and ventilation in the rotation of turbine wheels:

$$N_m = \frac{4R^2}{v}\left(\frac{u}{100}\right)^3 \text{ kw} \qquad \text{(IV-35)}$$

in which R is the wheel radius, in meters, v is the specific volume of air, in m^3/kg, and u is the peripheral velocity of the wheel, in m/sec.

Centrifugal Disk Design

Various types of centrifugal disks are now in existence. In atomizing coarse suspensions, viscous solutions and pastes, solid disks are usually employed (Figure 35). They are designed as platters (1) or saucers in upside-down position (2). Due to the high degree of slip, the speed at which the solution leaves their surfaces is smaller than with other types of atomizing disks. However, the spray is quite satisfactory, as the perimeter of wetted surface is large. Sometimes shallow channels are cut in

in the disks to reduce slippage of the solution. However, experimental data has shown that this increases the heterogeneity of the spray. When a solid disk is used, with sharp, vertical edges (3), the spray is coarser than with solid disks (1 and 2).

To prevent the slippage of the solution, disks are sometimes made with channels of circular or rectangular section, or else vane disks are used. In disks with channels (4), the solution is emitted in the form of individual fine streams, and the thickness of the film of solution leaving the disk is larger than with disks of other types. It may therefore be expected that, all other conditions being equal, a less dispersed spray will be obtained. In addition, when the discharge section of contracting slots are small, they stand in danger of clogging if the solution being atomized is contaminated or heterogeneous.

Disks with vanes present a more rational design. We know that the skidding of the solution depends upon the rate at which the film of solution traverses the surface of the disk. Skidding is negligible close to the center of the disk, where the rate of motion is small. By taking advantage of this feature in the motion of the film of solution, it is quite practical to set vanes at a considerable distance from the disk axis. This makes it possible to increase the perimeter of wetted surface with a disk of unchanged size and rate of rotation. The film of solution is displaced along the vertical axis of the vane, which makes it possible to attain uniform dispersion of the spray and its diameter, with increased rate of output, merely by increasing the height of the vane, no accompanying change in disk diameter being needed.

The following are the reasons why it is undesirable to increase disk diameter. To give larger disks the required strength, they must

be thicker, and this increases their weight. This creates a greater possibility of imbalance and also makes it harder to attain high rates of rotation. As disk diameter is increased, there is a less uniform distribution of the current of solution across the drying chamber due to the fact that the center of the spray is empty of solution.

Figure 35 illustrates disks with vanes of various shapes. Experimental data have shown disks with curved blades (5 and 6) to enjoy no advantage over disks with radial blades (7). Discs with curved blades are less economical in power consumption. This is explained by the fact that disks 5 and 6 require added energy in order to circulate the air, i.e., they act as fans. Disks with radial vanes are the most economical and simplest in design. They produce a good spray.

Certain disks designed to break up solid clumps in the solutions carry special inserts (pins), Figure 36, such as disk 8. Disk 9 has three atomization surfaces. The solution, coming from chamber a, passes through aperture b to the 3 surfaces, c, and is thrown off the sharp edges. The disk surface is smooth and conical. This design produces the most uniform spray, as the 3 surfaces give them a large wetted perimetric surface.

Table 7 adduces comparative data for various types of disks, calculated for an output of 680 kg/hr and a peripheral velocity of 64 m/sec.

TABLE 7

Feature	Unit	Disk 5	6	7	8	9
Average volumetric-superficial diameter, $\delta_{3.2}$	μ	161	152	170	150	170
Disk diameter	mm	152	178	127	127	178
Distance from disk axis at which						
90% of solution precipitates	mm	2560	2440	2320	2470	2310
50% of solution precipitates	mm	1800	2440	1700	1830	1770
Height of vane	mm	--	10.2	2.5	16.0	--
Length of vane	mm	--	25.0	25.0	--	--

The table makes clear that there is no significant difference in the spray produced by disks 5 to 9. Spray disks are now under design with diameters of 100 to 500 mm.

New designs of multiple disks are needed if high output is to be obtained with small spray diameter. Designs are required which will specify disks of small diameter, permitting high rates of rotation.

High rates of rotation may be produced by a steam turbine with back pressure, a high-speed high-frequency motor, or a motor with reduction gear. The turbine commonly used is of 10-12 kw power and 8 atm excess pressure. It rotates 140 times per second. The exhaust steam is generally used in radiators for air heating.

Figure 37 illustrates a reducing gear for driving a disk by means of a motor designed at NIOPIK. The disk, k, is mounted on a vertical shaft, 2, rotating on ball-bearings, 3, at the top of the shaft, and roller bearings, at its base. The solution to be

atomized is delivered in an inclined tube, t. The disk shaft is rotated by the motor, 6, which is mounted above a vertical shaft, 7, rotating in ball bearings, 8. A large, cylindrical gear, 9, with teeth set at an angle and engaging the small gear, 10, is mounted on this shaft. Both gears are housed in a case, 11. Lubricating oil for the motor shaft bearings and the gears is delivered via the tube, 12. Used oil flows out of tube 13. Oil for the disk shaft bearings is delivered via tube 14 and is rejected via tube 15.

Solutions of low viscosity are usually delivered to the disk by gravity flow. Viscous solutions are delivered under pressure or by special feeds. Figure 3? shows a gear feed analogous in design to a gear pump.

Advantages and Disadvantages of Atomization by Centrifugal Disk

Atomization by centrifugal disk possesses great advantages over the other methods. Highly-viscous solutions may be atomized by disks. This includes even coarsely-dispersed suspensions and pastes.

Disks contain no small apertures for the solution. As a result, they do not clog, are reliable, and deliver a uniform spray. Discharge of solution from a single disk may be varied 25% in either direction without significant change in dispersion and shape of spray. The output with a single disk may be as high as 5,000 kg/hr. The power consumption is a fraction of that with pressure spraying, and slightly higher than with mechanical.

The shortcomings of this method of spraying include the high cost of the spray apparatus, the complexity and particular care that must be given to maintenance, and in particular to the lubrication

and state of the disk itself, as otherwise the disk will go out of balance on starting, causing damage to the equipment, and under certain circumstances to the drying chamber itself. The broad diameter of spray means that the process requires larger areas than on spraying by other methods.

[Pages 124-144]

CHAPTER VI. RECOVERING THE DRIED PRODUCT

The gathering and removal of the very fine particles constituting the dried solution is an important problem in spray drying. The degree to which the dried product is recovered affects the economy of operation of spray driers. The economics of spray drying is particularly affected by the percentage recovery of dried product in the drying of expensive items of food, pharmaceuticals, and chemicals. In some cases, considerations of public health require complete purification of the waste gases rejected into the atmosphere.

The size of the particles obtained in spray drying varies greatly. Large particles are precipitated in the drying chamber, and small ones, despite the low gas velocities, are entrained in the gas and carried out of the chamber. Therefore, the recovery of the dried product involves its removal from the drying chamber, and the extraction of the very finest particles from the used gas.

Removal of Powder From Drier

Two methods, primarily, are used in industrial installations for removing the powder from the drying chamber. The first consists of the powder sliding down a chamber-bottom of conical

shape into a bunker or, via pneumatic transportation, being delivered to dust-separators. The second consists of removing the powder from the chamber floor by special tools (scrapers, brushes), and then removing the fine particles of product, along with the used gases, in dust-removers.

If the first method is to be used, the bottom of the drying chamber is made in the form of a truncated cone. The taper is based on the flowing properties of the particular dried powder.

When this method is used, the powder is, as a rule, completely covered in dust-extractors. No special attachments are required. The method is a simple one, if the dispersed powder flows freely. However, the drying chamber has to be very high. In addition, if spraying stops for some reason, the exit pipe may clog with moist powder, causing a breakdown.

If the powder is to be removed from the drier by means of a scraper or other equipment, a flat chamber-bottom is used. This permits a considerably lower chamber to be employed. Figure 47 shows the design of the scraper. A head, 2, to which spokes, 3, are attached, is mounted on the shaft, 1. Grips, 4, which may be moved along the spokes, are attached thereto. The grips are also capable of rotating on their vertical axes. The scraper 5, on an axis, 6, is fastened to the grip in a manner to permit free motion. The rotation of the grip around its vertical axis permits variation in the angle between spoke and scraper. The position of the scrapers and their angle of rotation in the horizontal axis depends upon the point at which the powder is removed from the chamber. When scrapers are used to remove the powder from the chamber, cooling or further drying is easy to arrange. This is done merely by giving the chamber a hollow bottom filled with cold or hot water.

The powder is recovered separately in the chamber and in the dust-extractor when it is desirable to separate it by fractions. Thus, in a spray drier part of the powder may be larger in grain size than is required. In such a situation, it is rational to remove the coarse powder from the drying chamber separately, and then to grind it.

Sometimes, the powder settled at the bottom of drying chambers is subjected to air blast for removal together with the used gases.

Compressed air from rotating nozzles is sometimes used to clean the chamber walls of precipitated dust.

Extraction of Powder From Gas Stream

Centrifugal extractors (cyclones), fabric filters, and wet separators (scrubbers) are the devices normally employed to extract the powder from the reject gas. Electrical filters are not generally employed to extract the dry powder from the gas current after drying, due to their high cost.

Centrifugal Dust-Extractors (Cyclones)

Various types of centrifugal dust-extractors are now in wide use in industry. Centrifugal cyclones are the most commonly employed in drying equipment, due to their simplicity and low cost. Cyclones extract 70 to 90% of the dust from gases.

Centrifugal force is used to separate dust within a cyclone. A cyclone usually consists of a cylinder the bottom of which is provided with a cone tapering at not less than 60°.

The dust-laden gases are delivered to the upper, cylindrical portion, of the cyclone, at a tangent to its periphery. The gas

in the cyclone moves downward in a spiral. The centrifugal forces set up in this manner throw the dust particles toward the wall of the cyclone, from which they drop into a bunker. The dust must not be allowed to accumulate in the bottom of the cyclone, as that reduces its efficiency. The purified gases are removed through a centrally-positioned rejection pipe. Any leaks anywhere in the dust-precipitation system sharply reduce the percentage of particles removed from the gas. If there is leakage into the dust-transport system, movement of air counter to the descending dust will set up, and a portion of the entrained dust will be carried off into the reject tube by the eddy in the middle. Air intake by leakage equivalent to 10 or 15% of the gas being purified may reduce the functioning of the apparatus to zero.

The gas velocity in the cyclone intake pipe is usually 10 to 20 m/sec. The velocity in the exit pipe is 3 to 8 m/sec.

The degree of purification of gas in cyclones depends upon the properties of the dust and the gas, the velocity of the dust-carrying gas flow, and the absolute dimensions and design features of cyclones. The fractional composition and density of the dust have a considerable effect on the functioning of cyclones. The larger and heavier the dust particles, the more complete the removal by cyclone.

Figure 48 presents the relationship of the percentage extraction to particle diameter in an NIIOGAZ TsN 15 cycline.

The velocity at which the gas stream enters the equipment through the intake pipe has a marked effect on cyclone efficiency. For every cyclone design there is an optimum efficiency at which the best gas-cleaning effect is obtained. This velocity usually fluctuates in a range of 20 to 25 m/sec.

The percentage purification of the gas is governed by the dimensions of the cyclone. The fact that cyclones deliver increased percentage extraction as they are reduced in size is made wide use of. Cyclones not more than 500 to 600 mm in diameter are now being installed for the cleaning of used gases subsequent to spray drying processes. If the amount of gas to be cleaned is high, batteries of cyclones, or multicyclones as they are called, are installed.

Of the various cyclone designs now in existence, the best percentage extraction has been demonstrated by the NIIOGAZ models. The design of this type of cyclone is adduced in Figure 49. It consists of an intake pipe, k, rectangular in shape, a casing, 2, and an exhaust tube, 3. In the top of the cylindrical portion of the cyclone casing, there is a cover designed as a 360° ascending spiral. The bottom of the body tapers as a cone with a dust-escape aperture. A shell, 4, may be installed atop the exhaust pipe to convert the rotary motion of the gas on exit from the cyclone to linear motion. A bunker, 5, with a dust-unloading mechanism, is provided as a requisite for the cyclone.

The standards of NIIOGAZ use the TsN-15 cycline, with an intake pipe angle of 15°, as typical of the line. A lower version, TsN-15u, has been developed to meet conditions where reduced height is desirable. However, its efficiency of extraction is lower, all other conditions being equal, than that of the TsN-15. The high-output cycline, TsN-24, may be used for first-stage extraction when the dust is in high concentration and consists of large particles. To trap small particles (5 to 10 μ in diameter), a high-efficiency TsN-11 cyclone has been developed with its cover and intake pipe at an angle of 11°.

Cyclone Analysis

This consists of calculating the diameter needed to deliver the specified output with gas of given parameters, and of determining its hydraulic resistance.

The hydraulic resistance of a cyclone is calculated by the equation:

$$\Delta p = \xi \frac{\rho_r \cdot u_y^2}{2g} \text{ mm water column} \qquad \text{(VI-1)}$$

in which Δp is the hydraulic resistance of the cyclone in mm water column; ρ_g is the specific gravity of the gas in kg/m^3; u_y is the nominal gas velocity in the cylindrical portion of the cyclone, in m/sec, and ξ is the coefficient of hydraulic resistant in terms of the nominal gas velocity.

The nominal gas velocity in a cross-section of the cyclone is

$$u_y = \frac{4V}{\pi D^2} \text{ m/sec} \qquad \text{(VI-2)}$$

where V is the gas flow, in m^3/sec, and D is the cyclone diameter, in meters.

The coefficient of hydraulic resistance, according to experimental data of NIIOGAZ is as follows:

Cyclone model	ξ
TsN-15	105
TsN-15u	110
TsN-24	60
TsN-11	180

Based on considerations of industrial economics, and the

demands of reliable operation, the diameter of the cyclone must be such that the ratio of hydraulic resistance to the specific weight of the gas will be in the range of:

$$\frac{\Delta p}{\rho_г} = 55 \div 75 \text{ м.} \qquad \text{(VI-3)}$$

Within these limits of the $\Delta p/\rho_2$ ratio, the NIIOGAZ cyclones will remove 80 to 90% of the particles from gas.

If we write in a specific value for the hydraulic resistance of the cyclone in accordance with equation (VI-3), its diameter may be determined by the equation:

$$D = 0{,}536 \sqrt[4]{\frac{V^2 \rho_г \xi}{\Delta p}} \text{ м.} \qquad \text{(VI-4)}$$

Having calculated the diameter of a cyclone, its other dimensions are determined in accordance with the standards developed by NIIOGAZ. The ratio of the major dimensions of the cyclone to its diameter are presented in the table in Figure 49.

Where high output is involved, battery cyclones are sometimes employed in place of a number of individual cyclones. Small-diameter battery cyclones (150-250 mm) are usually called multicyclones. The design of a multicyclone is illustrated in Figure 50. The gas is caused to rotate by means of a special attachment between the cylinder wall and the escape tube. The attachment consists of sockets in which vanes are mounted at 20 to 30° to the cylinder axis, or of screw-type vanes.

Figure 51 shows an NIIOGAZ battery cyclone consisting of a group of ordinary cyclones. Their principle of operation is evident from the drawing.

In making a decision regarding battery cyclones, it must be

remembered that they remove a smaller percentage of particles from gas than does a single cyclone of identical dimensions. This is because the storage hopper beneath may permit gas flow from one cyclone to another. The hydraulic resistance of cyclone batteries is 10% higher than that of a single unit.

Cloth Filters

Cloth filters may be used when the temperature of the gases emerging from the drier is low, and the flue gas contains little SO_2 and no SO_3. In cloth filters, the dust-laden gas is passed through close-woven cl th. Sleeves are the most widely-used filter design.

A sleeve filter (Figure 52) consists of a wooden or steel box divided into several chambers. Cloth sleeves open at the bottom and closed at the top, are suspended in each chamber. The dust-laden gases enter the sleeves through the openings at the bottom and pass through the cloth, depositing the dust therein. The sleeves are fastened to the bottoms of their respective chambers. At the top they are suspended from ring-shaped levers which are used to agitate them, successively, from time to time. To facilitate cleaning of the cloth when this is done, the door to the first chamber is closed, and the door to the second opened, so that the air delivered from without by a fan provided for the purpose, enters at a pressure of 90-120 mm water column, penetrates into the cloth from without, and cleans the pores of the cloth. The dust shaken out of the filter mesh, falls to the bottom and is removed to a hopper by conveyor.

Cloth filters remove 98 to 99% of the matter in gas originally containing 110 to 150 mg of dust particles per cubic meter.

Sharp turns in the air current, and the resistance of the cloth itself, require the application of considerable pressure head. The total resistance of the filter is 60 to 100 mm water column. Filters function best under pressure.

The gas temperature in a cloth filter should be between 60 and 100°. Blowout is usually by heated air to prevent condensation of the dust and clogging of the filter thereby. Care must be taken that the gas temperature is above the dew point. In addition, to prevent condensation of the vapor, the filter housing must be insulated.

The efficiency of gas purification in cloth filters depends upon the fineness of the dust to be trapped. The finer the dust the lower the efficiency. The percentage dust content of the air is of less importance in determining the degree of purification, while the absolute dust content in the gas after the filter rises, along with a rise in initial dust content. However, the higher the initial dust content of the gas, the higher the filter efficiency. To a small degree, the filter efficiency is affected by the load on the fabric, i.e., the amount of gas transmitted per square meter. The higher the load on the fabric, the poorer the efficiency of the filter.

The resistance presented by the cloth filter sleeves depends both upon the type of cloth, and upon its load and dust content.

The resistance of cloth filter sleeves may be determined from the following:

$$\Delta p = (kz_p + a_0)B^{b_0} \text{ mm water column}$$

in which B is the unit load on the filter in $m^3/m^2/hr$; z_p is the dust content of the cloth in g/m^2, and k, a_o, and b_o are indices whose value, for various types of fabric, is adduced in Table 8.

TABLE 8

Fabric	Type of dust	k	a_0	b_0
Wool	From a sand blaster	$791 \cdot 10^{-7}$	$5.03 \cdot 10^{-3}$	1.012
Serge, 50% wool	From a sand blaster	$1980 \cdot 10^{-7}$	$5.34 \cdot 10^{-3}$	1.11
Coarse calico	From a sand blaster	$915 \cdot 10^{-7}$	$3.24 \cdot 10^{-3}$	1.17
Wool baize	From a sand blaster	$1195 \cdot 10^{-7}$	$4.97 \cdot 10^{-3}$	1.10
Cotton baize	From a sand blaster	$2450 \cdot 10^{-7}$	$7.56 \cdot 10^{-3}$	1.14

Wool fabrics with a nap retain dust better than cotton, while their resistance is lower.

In installing fabric filters behind spray dryers, the load on the fabric is usually set at 60 to 200 $m^3/m^2/hr$.

Fabric filters have the following shortcomings. The sleeves must be replaced rather frequently, as they undergo a constant decline in filtering capacity (a sleeve is usually not good for more than a year). Secondly, the presence of SO_2 and, particularly, of soot, in the gases, increases filter wear. Thirdly, resistance rises while the filter is in use. Furthermore, gases may not be cleaned at temperatures higher than 100°.

Wet Dust-Extractors

Under certain conditions, more perfect recovery of the dust is obtained by installing, after the cyclone, one of a variety of types of chambers, in which a mist of an atomized liquid is created. The principle of operation of this type of dust-trap is that the particles of dust adhere to the film of liquid on striking it.

The force of adhesion between particle and film is so great that the particle cannot, as a rule, be pulled free by the current of gas and be carried out of the chamber with the fluid. Dust extractors operating on this principle are generally called wet scrubbers. The most economical dust-trapping medium -- whenever it can be used -- is the very solution to be dried, which goes directly to the spray drier after leaving the scrubber. When this cannot be done, water is always the medium used. The use of wet scrubbers is of high significance in spray drying, as they are employed not only as dirt but as heat, traps. The heat of the used gases is used in the heating and preliminary thickening of the solution to be dried, a process which markedly improves the economic indices of spray driers. Wet scrubbers are highly efficient in trapping the finest particles of dust. The degree to which the gases are cleaned is 90 or 98% or more, depending upon the physical properties of the particles and the liquid to be atomized.

The percentage of extraction rises with the increase in temperature of the liquid. Recirculation of the liquid in the wet scrubber makes possible elevation of its temperature without special heating.

Various designs of wet scrubbers are now in use. By principle of operation they may be divided into scrubbers with packing, wet inertia dust-catchers, and scrubbers with nozzle atomization of the liquid. A packed scrubber is a vertical and, usually, cylindrical structure. There are 2 apertures in the side walls at top and bottom to admit and permit the escape of the irrigant liquid and gas. Within the scrubber, 1.5 m from the floor there is a grating to hold the packing. The purpose of the packing is to provide the

required contact surface.

The packings most generally used are fragmented materials (quartz, coke, gravel), substances of specific geometric shape (Raschig rings, balls, plates, etc) and wooden grids.

The major requirement to be met by a scrubber packing is maximum surface area per unit volume with minimum resistance by the layer of packing to passage of the stream of gas.

As a rule, all scrubbers operate on the principle of counterflow. The liquid is pumped upward and flows down in a direction opposite to that of the gas, which moves upward in the scrubber. The gas velocity in packed scrubbers is usually one meter per second, measured across the entire section. Due to the large surface of contact between the liquid and the gas, in packed scrubbers, the percentage extraction of gases from the dust is very high.

On the other hand, packed scrubbers are rarely used in spray drying, as the packings are subject to fouling, particularly in trapping insoluble dust particles. In addition, this type of scrubber is rather bulky and is of high hydraulic resistance.

Wet Inertia Dust Catchers

The VTI centrifugal scrubber is the most worthy of attention, among extractors of this type (15). The VTI centrifugal scrubber consists of a vertical cylinder terminating in a conical funnel at the bottom (Figure 53). A rectangular hole to which a horizontal pipe is welded tangentially is cut in the wall at some distance from the bottom. The upper portions of the cylinder walls are irrigated with liquid which flows down the cylinder as a film.

The gases enter the cylinder through the tangential pipe and, ascending in rotary motion, rise in a spiral, escaping through the upper portion of the cylinder. The particles contained in the gases move radially, reach the film of water, wet it, and wash out via the funnel and a water seal. The unit flow of liquid is 0.2 lit/m^3 of gas with a scrubber one meter in diameter. The consumption of liquid declines with increase in diameter. The percentage purification of the gas depends upon a large number of factors, including scrubber diameter. It is 87 to 91% for scrubbers one meter or less in diameter.

Scrubbers are usually not made more than 1.2 to 1.3 m in diameter, and are designed in accordance with the gas load to be handled, gas velocity being taken as not more than u = 6 m/sec, and 20 to 23 m/sec in the intake pipe.

The hydraulic resistance is calculated by the formula

$$\Delta p = \frac{\xi \rho_0 u^2}{2g\left(1 + \frac{t_1}{273}\right)} \text{ mm water column} \qquad \text{(VI-6)}$$

in which t_1 is the temperature of the entrant gases, in °C, ρ_0 is the unit weight of the gases, at 0°, in kg/m^3, ξ is the coefficient of hydraulic resistance, and u is the gas velocity in m/sec, relative to the total cross section.

Six nozzles are provided so as to assure a uniform film of liquid on the inside surface of the scrubber. The rate of flow, u is taken as 3.5 to 4.0 m/sec.

The pressure head required above the nozzles to drive water through them is calculated on the formula

$$p = \frac{1.10\,[illegible]}{[illegible]} \text{ atm excess pressure} \qquad \text{(VI-7)}$$

The total consumption of water is calculated on the maximum gas flow based on a unit flow of 0.2 lit/nm^3 gas. The temperature of the gases on emerging from the scrubber, t_2, may be calculated roughly by the formula:

$$t_2 = 0.6t_1 + 0.4t_m \ ^{o}C$$

in which t_m is the temperature of a wet-bulb thermometer in ^{o}C.

Figure 53 shows the prime dimensions of a scrubber in percentages of diameter.

The VTI centrifugal scrubber is small-dimensioned and offers a high level of gas purification with low consumption of liquid. However, it provides high resistance (up to 50 mm water column). This scrubber cannot be used as a heat-consumer. In addition, when the process calls for purification of the gas by means of the solutions to be dried, and these are viscous and concentrated, the inside surface of the scrubber may not be completely wetted, and the solutions may dry on the walls.

Wet scrubbers, in which the liquid is atomized by coarse-spray mechanical nozzles, constitute the type most widely used for second stage purification of used gases after the spray drier. The design of such a scrubber is adduced in Figure 54.

The scrubber is a vertical cylinder with conical floor. The dust-laden gases are taken in radially via windows around the perimeter below the cylindrical portion of the scrubber. The gases emitted from the distributor windows, rise, pass through the atomized liquid, are cleansed, and rejected into the atomosphere. The liquid is atomized by coarsespray mechanical nozzles (see Figures 22, 23). The nozzles are at a fixed angle to the horizontal on the

perimeter at some distance from the top of the scrubber. This position permits uniform distribution of the density of the flow of atomized liquid across the scrubber. Sometimes the nozzles are mounted on one or more banks across the scrubber with the spray pointed downward. The liquid is collected in the conical bottom. To prevent the liquid from entering the gas—distributor channel, a baffle is built over the windows around the entire perimeter. An overflow drain is provided in the conical portion to prevent the liquid from entering the gas line if the exit line should clog.

Wet scrubbers may or may not employ recirculation of the liquid. If they do, the density of irrigation is higher, purification of the gas is better, and the heat of the used gases may be more completely employed. The irrigation density is the hourly atomization of liquid in kilograms or cubic meters per square meter of scrubber cross-section. The functioning of a scrubber with recirculation is illustrated in Figure 54. The principle of recirculation consists in the fact that a portion of the scrubber liquid goes to atomization along with fresh liquid added from the storage tank. The amount of liquid newly returned, i.e., the rate of recirculation, is determined by calculation in accordance with required area of irrigation, the physical properties of the solution or liquid, and the amount of dry product recovered.

Scrubber Analysis

Scrubbers with nozzle atomization of liquid are used for dust-trapping and the utilization of the heat of the used gases for drying. If the solution to be dried, which then proceeds to the spray dryer, is used in the scrubber, the scrubber is designed

to prevent condensation therein of the used gases into liquid. If this were not done, this portion of the condensed moisture would again have to be evaporated in the spray drier. If water be used as dust-extractor and heat trap, and this water is then to be used industrially, the scrubbing process must provide for condensation of the water vapor from the used gas. This makes it possible to make use of the large amount of water contained in the used moist gas after drying.

The scrubber diameter, D_{ck}, is determined by analysis of the gas velocity in the upper portion of the scrubber, on the formula:

$$D_{ck} = \frac{1}{30} \sqrt{\frac{Lv_0}{\pi u}} \text{ м}, \qquad \text{(VI-9)}$$

in which L is the hourly gas flow, in kilograms per hour, v_0 is the volumetric weight of the wet gas per kilogram of dry gas, in cubic meters per kilogram, and u is the gas velocity in the scrubber, in meters per second.

The gas velocity is such as to prevent escape of droplets of solution or liquid from the scrubber. Loss of liquid would otherwise rise rapidly as the gas velocity in the scrubber rises. For example, N. M. Mikhaylov's data (31) gives us the following carry-off of liquid in coarse spraying, relative to gas velocity:

Scrubber gas velocity m/sec	Scrubber liquid lost (%)
0.5	0.3
1.0	0.8
1.5	1.5
2.0	3.2
2.5	6.0
3.0	10.0

It is clear from these data that, in coarse spraying, gas velocity in the scrubber may be taken as up to 1.0 m/sec.

Drop traps of various designs are sometimes set up to catch drops on exit from the scrubber. Under certain circumstances, a packing of Raschig or other rings, which in turn are also irrigated by liquid or solution, may be provided over the nozzles to prevent fine drops from being carried out of the scrubber. In such scrubber designs a finer spray, permitting more effective dust-removal from the gases and employment of the gas heat, may be provided.

The scrubber volume (V_{ck}) is determined from the heat equation, on the formula:

$$V_{ск} = \frac{Q_{ск}}{a_v \Delta t_{cp}} \text{ M}^3 \qquad \text{(VI-10)}$$

in which Q_{ck} is the amount of heat expended in heating the solution and evaporating liquid therefrom, in kcal/hr, a_v is the volumetric factor of heat exchange in kcal/m^3/hr/$^{\circ}$C, and Δt_{av} is the average temperature differential between gas and liquid, in $^{\circ}$C.

The amount of heat, Q_{ck}, that may be expended in the heating and preliminary thickening of the solution, is determinable on the formula:

$$Q_{ск} = L(I_1 - I_2) - Q_5 \text{ kcal/hr} \qquad \text{(VI-11)}$$

in which I_1 and I_2 are the enthalpies of the gas at the initial moisture content ahead of the scrubber, and at the gas temperature before and after the scrubber, respectively, in kcal/kg, and Q_5 is the heat loss to the medium in kcal/hr.

The gas temperature after the scrubber is determined by the plotting of the actual process on an I-d diagram, taking its

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relative humidity at 80-90%. If the process be accompanied by condensation of vapors of liquid out of the gas, the difference in the heat content of the moist gas before and after the scrubber is written into equation (VI-11).

The average temperature differential, Δt_{av}, may be determined to high accuracy when the scrubber operates with recirculation of the solution, as its temperature under this condition is close to the wet-bulb thermometer temperature, viz.:

$$\Delta t_{cp} = \frac{t_1 - t_2}{\ln \frac{t_1 - t_M}{t_2 - t_M}} \; ^\circ C, \qquad (VI\text{-}12)$$

in which t_m is the mean wet-bulb thermometer temperature, in $^\circ C$, while t_1 and t_2 are the gas temperatures, respectively before and after the scrubber, in $^\circ C$.

When recirculation is not provided, the coarse atomization results in the unstable pattern of drop heating comprising a considerable portion of the whole, and sometimes the solution fails to attain the temperature of the wet-bulb thermometer. On the other hand, it may be accepted, with some allowance, that the temperature of the solution in exit from the scrubber will be equal to that of the wet-bulb thermometer. In that case, the mean temperature differential, Δt_{av}, may be calculated on the formula:

$$\Delta t_{cp} = \frac{(t_1 - t_M) - (t_2 - \vartheta_0)}{\ln \frac{t_1 - t_M}{t_2 - \vartheta_0}} \; ^\circ C, \qquad (VI\text{-}13)$$

in which θ_0 is the temperature, in $^\circ C$, of the solution entering the scrubber.

The volumetric coefficient of heat exchange, α_v, may be determined by the empirical formula obtained by N. M. Mikhaylov (32)

in concentrating sulfite caustics, i.e.

$$\alpha_v = 95\ A^{0.82}\ \text{kcal/m}^3\text{/hr/}^\circ\text{C} \qquad \text{(VI-14)}$$

in which A is the density of irrigation in $t/m^2/hr$.

Equation (VI-14) was obtained on results obtained by varying irrigation density within the range of 0.6 to 3.5 $t/m^2/hr$. a pressure of 2 scrubber of from 0.3 to 1.5 m/sec.

Equation (VI-14) shows that the volumetric coefficient depends upon density of irrigation. Consequently, scrubber volume required may be considerably reduced by recirculation. However, it is to be noted that under certain conditions, i.e., in the atomization of hydrophobic suspensions, or of viscous and concentrated solutions, an increase in the factor of recirculation results in difficulties in obtaining satisfactory and reliable atomization with the usual coarse-spray mechanical nozzles.

The working height, H_{ck} is determined from the volume and diameter of the scrubber:

$$H_{ck} = \frac{4V_{ck}}{\pi D^2_{ck}}\ \text{m} \qquad \text{(VI-15)}$$

By working height is meant the distance between the gas intake and the nozzles.

The scrubber resistance is usually not more than 10 or 15 mm water column.

Selection of Dust Extractor

The choice of a proper dust-extractor design depends upon many factors and must be arrived at independently in each given

instance. The choice is governed by the pattern of drying, the system of removing the powder from the drying chamber, the dispersion of the particles, the cost of the product obtained, the physical properties of the solution and powder, etc.

In spray drying, the dust is usually recovered in 2 stages, not counting precipitation of dust in the drying chamber. Single or triple-stage purification of the gas after the drier is used, but rarely.

When a wet recovery process and preliminary heating of the solution to be dried do not affect the quality of the resultant product, it is rational to use wet scrubbers as the second stage in gas purification. This increases economy, and permits high purification of the gases from dust. The most rational system is the use, if possible, of the very solution to be dried, as the means of recovering the dust in the scrubber. When concentrated coarse hydrophobic suspensions are to be dried, it is difficult to use them to trap the dust, due to the unrealiability of mechanical nozzles in this situation. However, it is sensible to use wet scrubbers irrigated with pure water as the second stage of gas purification in this situation, as the suspension produced by trapping the dust may readily be concentrated to the desired size by simple settling in precipitation tanks.

Centrifugal cyclones are usually employed as the first stage in purification. Use of cyclones and a wet scrubber constitutes the most reliable method in terms of the problem of changes in the temperature regime at which drying is performed. This method may be used with various drying gases, and for drying out of various liquid solutions.

When hot air drying is the method, cloth sleeve filters are often used for gas purification. Cyclones are mounted ahead of the filter to reduce the load and obtain more reliable operation. Cyclones are not provided at this point if the process does not require all the dried powder to proceed to dust-extraction, but a portion is removed directly from the drying chamber.

In special cases, purification of the gases from the dust proceeds through 3 stages: cyclones, cloth filters, and scrubber. This pattern of dust-removal involves a marked increase in consumption of electric power for ventilation, due to the high resistance of the system. Sometimes only centrifugal cyclones are used for getting the dust out of the gases. This is usually the process in cases in which furnace gases are used for drying, the cost of the product is small, and the rejected dust causes no harmful fouling of atmospheric air.

Seals

Special seals are provided for the dry-powder discharge-holes of the drying chamber of cyclones, so as to prevent air from being sucked into installations in which the pressure differs from that at the point where the product is discharged.

Vane seals or "winkers" are the most commonly used. A "winker" is a rocker valve the purpose of which is to protect some element of the system from intake of air as a flowing substance passes from one pressure zone to another.

The "winker" is opened by the weight of the powder above it and is kept open as the powder goes past it. As soon as the powder movement has ceased, the valve checks leakage by means of a weight

that balances that of the powder and the difference in pressure. When the powder is in motion, the seal is provided by the column of dust atop the winker. The height of this column is determined by the pressure drop that has to be maintained when the flowing material is allowed to go past the "winker." The height of this column is calculated to permit the weight of the flowing substance above the "winker" to counterbalance this pressure drop. Thus, if the vacuum in the cyclone be Δp_u kg/m^2, in millimeters water column, and the dust is to be disposed of into a container in which there is no vacuum, the height of the dust column above the winker, given a volumetric weight of γ_n kg/m^3, is obtained by means of the equation

$$H_n = \frac{1000 \cdot \Delta p_u}{\gamma_n} \text{ mm} \qquad (\text{VI-16})$$

Figure 55 illustrates a winker mounted in vertical and inclined flows. A peculiarity of the given design is that the gate of the valve is at 60° to the angle of flow, to permit a more uniform descent of the material, and consequently the best possible seal, and greater reliability than with a clap-counterweight valve. Table 9 adduces the dimensions of the "winker."

Figure 56 shows the design of a VTI winker mounted for vertical flow. The axle, 1, of the gate, rests on two knife-edges, 2. An arm, 3, mounted on the axle, carries on one side the weight 4, and on the other a pin 5, bearing a conical valve 6 which rocks freely on the pin. The entire mechanism, with its counterweights is in an air-tight housing 7.

This design provides a good seal and works more evenly than those in which the powder descends on one side only.

In addition to "winkers," vane seals are used for the purpose in question (Figure 47). In such a seal, designed by the VTI, the

rotor, 2, rotates toward the flow of dust through the outlet. The dust fills the rotor compartment through the aperture formed by the vertical wall of the channel and the inclined leaf. The position of the leaf is such that the rotor compartment cannot fill completely. This prevents the seal from sticking and makes for reliable function of the sealing apron, 3, mounted 0.5 mm over the finished surfaces of the seal. The seal is operated by a motor, via reduction gear.

TABLE 9

	Diameter of winker-valve, in mm			
Symbol	203	250	300	350
d	203	250	300	350
D	219	266	316	366
a	150	175	200	225
σ	245	270	295	320
β	125	125	150	175
ε	385	445	500	560
δ	885	945	1000	1060
η	485	545	600	660

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CHAPTER VIII

SPRAYER EQUIPMENT DESIGNS AND CHOICE OF CONDITIONS OF DRYING

Sprayer Equipment Designs and Processes

The design of the drying chamber and the conditions of operation of the drier, which involve the decision as to manner of product recovery, spraying method, etc, are largely governed by the properties of the solution to be dried, and the desired characteristics

of the final product. For this reason, there is no universally-applicable method of drying or equipment design applicable to the drying of all types of solutions. The problem of proper drier design and equipment layout must be resolved anew in each specific instance. Every branch of industry has its own spray drier designs and drying procedures aimed at obtaining the product meeting its requirements. For example, a drier designed to obtain a highly-dispersed powder cannot be used for drying a coarsely-dispersed solution without remodelling. The drier operating on a coarse spray is larger and more expensive.

Choice of sprayer design and equipment layout is usually based on the following factors: (a) the nature of the end product (size of dry particles, moisture content, volumetric weight, etc); (b) method of spraying the solution; (c) initial concentration of the solution; (d) temperature conditions of drying; (e) method of removing the dried product from the drying chamber, and of extracting the powder. In the majority of cases, these data are determined experimentally.

Spray driers operate within a broad range of conditions. The solutions to be dried may vary from 30% moisture content (paste) to 99%. The gas temperature at the drier intake may be from 100 to 800°C. The moisture content after drying may be from 0.2 to 25%, etc. Below we shall examine the considerable variety of designs and layouts that are now in use to meet the various drying requirements and properties of the solutions to be dried.

Figure 63 illustrated a spray drier with centrifugal atomization of the solution. The disk, 4, is rotated by the motor via a reduction gear, 6. Heated air enters the distributor chamber, from which it proceeds, via a special screen, to the drying chamber,

from which it proceeds, via a special screen, to the drying chamber, 1. The air moves in direct flow relative to the atomized solution and, descending, dries it. The dried, large particles deposit on the bottom of the drying chamber, and are transferred to the screw conveyor, 11, by means of the scrapers, 7, making two or three revolutions per minute. In this design, the screw conveyor is also a seal against intake of outside air into the drying chamber. The scrapers are operated by an electric motor, via a reducing gear and a system of conical gears. The used air, bearing very fine particles of the product, then passes through the cloth filters, 2, is cleaned, and is rejected into the atmosphere by the blower, 9, taking it up through the duct, 10. The powder caught in the filters falls to the bottom of the chamber when they are shaken, and is removed from the chamber by scraping. The cloth filters must be cleaned when the drier is not in operation, the procedure being to blow air through them in the opposite direction.

This design is compact, provides good distribution of the air through the drying chamber, and the product is removed at a single outlet. Driers of this type are suited for drying by air heated to not over 140°C. They possess the disadvantage that it is difficult to clean the filters when clogged with the product.

Figure 64 adduces a spray drier with pressure atomization of the solution. The drying chamber, 7, has both cylindrical and conical sections. The solution is delivered by pump to the container, 5, from which it is sprayed by injection due to delivery of compressed air to the nozzles (air at 2.5 to 4.0 atm excess pressure). The air is purified in oil or paper filters, 1, is heated in a steam heater, 2, and is driven into the drying chamber tangentially by a blower, 3.

The atomized solution is washed by air which passes parallel to the product in a spiral flow. The dry powder, settling onto the walls of the conical portion of the chamber, goes along with the used air by pipe to the centrifugal cyclone, 8, in which as much as 80% of the powder may be extracted. From the cyclone, the air, still containing the very finest particles, is driven by blower to the sleeve filter, 9, and, freed of powder, is rejected to the atmosphere by another blower. The powder extracted in the cyclone and filter is delivered through the cyclone by compressed air to the storage hopper, 11. Sometimes a screw conveyor is used to collect the product from the cyclones and filter. Twelve to 36 nozzles, each having a capacity of 120 to 150 lit/hr are used, depending upon the size of the drier. Drying chambers are built in sizes up to 8 m in diameter and 16 m in height. The vacuum below the chamber is usually maintained at about 2 mm water column. These driers have often been found to show fouling of the line from drier to cyclone, particularly if the drying routine is violated for some reason (poorer spray, decline in air volume due to clogging of cloth filters, etc).

Figure 65 adduces the schematic of a drier with mechanical atomization of the solution. The drying chamber is a cylinder 6 m in diameter and 7.2 m high. The total volume of the chamber is 217 m^3. The drier is made of 2.5 mm zinc-plated sheet iron erected on a metal plate, with the sprayer column passing through its center. The outside of the drier is covered with a 30-mm layer of insulation, consisting of asbestite, infusorial earth, and cement. The drier rests on a reinforced concrete base standing on 10 columns.

A mobile tubular framework, on which 9 nozzles are mounted,

is housed in the chamber on the iron sprayer column. The framework rotates at 1.5 rpm.

The solution, after passage through special filters, enters a storage space, 1, from which a pump delivers it through a pressure equalizer, 3, to the nozzles, 6, at 35 atm pressure. The spray is directed upward. The air is delivered to the upper, conical portion of the drying chamber by a blower, 7, via a steam heater, 8. Four concentric mouths are placed in the pipe neck to distribute the air evenly across the section of the chamber. In its path across the chamber, the air encounters the atomized solution and dries it. The entire drying process occurs, for the most part, with air and product in parallel currents. Below the drying chamber the air stream is divided in 2, passes the cloth filter, 9, and is rejected into the atmosphere by blowers. The powder settling at the bottom of the chamber is swept into hoppers through 2 holes, by means of brushes. The brushes are mounted on a cross piece which rests, in turn, on a rotating column. The powder from the bunkers and filters sieves into a worm conveyor, 10, by which it is delivered for packaging in special containers, 11.

A shortcoming of this drier design is the difficulty in servicing mechanical nozzles, and the less-than-uniform distribution of the hot air across the drying chamber. Driers of this type are used for hot air drying.

Figure 66 shows a spray drier working on the principle of intermixed motion of the current of gases and solution. The drying chamber, 7, is like a centrifugal cyclone in appearance, and is made of welded sheet steel. The outside air is taken in through a filter, 11, by a blower, 9, and is driven into the drying chamber tangentially through the steam-operated heater, 10. The solution

is delivered to a feed tank, 1, from which a pump raises it to the heat exchanger, 4. The purpose of this heating is to reduce the viscosity of the solution as well as to raise its heat energy.

A second centrifugal pump draws the solution from the heat exchanger, 4, and the tank with stirrer, 5, and delivers it to the scrubber, 15, where it is atomized into a coarse spray by means of the mechanical nozzles, 16, at a pressure of not more than 4 atm. The used air from the drier containing fine particles of solution flows counter to the atomized solution. Interaction between the air and the drops of solution produces a process of evaporation and precipitation of the dry particles from the air current. The purified air from the scrubber is rejected into the atomosphere, after first having passed through a drop trap, 17. The condensed solution, with the particles trapped in the scrubber, flows by gravity to the stirring tank 5, from which part of it goes to recirculation and another part is pumped to the deaerator, 6. This removes the air, thus making for an increase in the volumetric weight of the powdered product. From the deaerator, the solution is taken by a high-pressure pump to mechanical nozzles in the drying chamber. Atomization goes at 100 to 200 atm. The drops of solution, moving downward in a spiral parallel to the movement of the air, dry out, and the powder precipitates on the bottom of the drying chamber. The air rises axially along the axis of the chamber, again passes through the spray, and goes to the scrubber. The drying chamber usually operates under pressure. The powder is discharged from the drying chamber through a seal.

To reduce the powder to lower moisture content, it is further dried in the suspended state on emerging from the drier by dry, hot air, while being transported by air pressure. The dried powder is

extracted in cyclones, 13, and is air-cooled, also during pneumatic transport. The cooled powder is recovered in cyclones and proceeds from the hopper to the packing machine, 14. The air leaving the cyclones with very fine particles of the product entrained, is driven by blower into the scrubber, 15. If heat-sensitive substances are to be dried, the walls of the drying chamber are sometimes water cooled to prevent heating of the particles contacting them.

In this type of drier, it is also possible to employ, as drying agents, fuel combustion products at temperatures up to 400°C. For operation at this temperature, the inside surface of the cylindrical portion of the drier is cemented with gunite. In a drier of this design, centrifugal spraying is not best practice. The advantage of driers working as centrifugal cyclones is that the used gases emerge with a high degree of saturation.

The process described above is sometimes employed in drying milk.

Figure 67 illustrates equipment in which the powdered product is removed from the air in 2 stages. The drying chamber consists of cylindrical and conical parts. The heated air is delivered by pipe directly to the spray disk. A portion of the dried product falls to the bottom of the drying chamber and pours through a seal, 7, to an air line, 8. The used air is freed of powder in 2 cyclones in series, 9. The dried product is delivered to a third cyclone, 9, by air pressure. The air leaving this cyclone is again returned to the powder-extraetor. The powder tends to settle in the air lines to and from the drying chamber, so that when this system is used for heat-sensitive solutions, there is the probability that part of it will spoil due to over-heating.

Figure 68 adduces the pattern of a drier with centrifugal atomization of solutions. The solution is delivered from the tank, 6, to a centrifugal disk, 4. The disk is mounted in the center of the drying chamber and is caused to rotate by a small steam turbine or a motor acting through a reduction gear. The air heated in the steam heater, 2, is driven to the distributor column, 3, and enters the drying chamber via openings in the column immediately adjacent to the disk. The large dry particles fall to the bottom of the drying chamber, from which they are removed by mechanical scrapers, 5. The fine particles rise to the top of the drying chamber with the air current, and then proceed to the cloth filters, 7. The gases undergo the final removal of powdered product in the filters. Sometimes, in driers of this design, the heated air is further carried by pipe to the upper portion of the atomizing disk or is delivered along the periphery of the drying chamber to the level of the spray. Drying chambers of this design are in fairly wide use in the food industry, although they cannot be regarded as representing the best possible practice. The major difficulty with these driers is that encountered in using drying agents of elevated temperature, as the dried powder, settling to the bottom, is in the high-temperature region, and is subject to spoilage due to overheating. The introduction of additional air by various means does not result in significant increase in the intensity of drying, while the unit consumption of heat per kilogram of evaporated moisture increases.

Figure 69 illustrates an installation using pressure atomization to dry hydrophobic heat-sensitive suspensions. The air is delivered to a gas-operated heater, 4, by a blower, 3, through a filter 2. The air is heated by furnace gases obtained by burning solid fuel

in a furnace, 1. The air, which may be heated up to 350°C, is delivered to a distributor manifold in the top of the drying chamber. From the manifold, the air enters the chamber radially at 10 m/sec through adjustable vents. From a tank with stirrer and steam jacket, 7, the heated solution goes by gravity flow to the pressure nozzles, 6. Large particles fall to the bottom of the drying chamber, while small ones are entrained in the used air and go to a cloth filter, 9, from which they are removed and stored in a hopper, 14. From the drying chamber, the powder goes to the mill, 13, and from there by pneumatic conveyor to a cyclone, 10, from which it proceeds to the storage hopper, 14. The used air is driven by blower to the centrifugal scrubber, 11, in which the water is atomized. The scrubber operates with recirculation of water (as solution). The material recovered in the scrubber from the air stream goes to special settling tanks as a suspension in low concentration. It may also be used to wash the initial suspension, if this is called for by the given procedure. It is difficult to produce in the scrubber a suspension of the concentration required for spray drying, as it is hard to handle such a suspension through mechanical nozzles.

Figure 70 shows a somewhat different pattern of drier operation and design. Here, too, the air is heated in a gas heater, but this one employs recirculated furnace gases. The heated air enters the drying chamber, 5, at a tangent. The used air is discharged in the middle of the chamber. The lower portion of the drier takes the form of a double truncated cone. A portion of the powder precipitates in the drying chamber when the air current changes direction at the outlet. The rest of the dried powder is trapped in the cyclone battery, 7. The used air is delivered by a blower 2, to a wet scrubber, 10, for removal of residual powdered product.

To prevent the drops from being carried out of the scrubber, a packing of Raschig rings, 15, is provided at its top. This is irrigated by the solution to be dried. This type of scrubber design is usually employed in the drying of true solutions, when there is no danger that the packing will clog. This type of drying chamber design permits the air to be withdrawn at a single point, and enables communication of air lines between the drier and the first-stage dust-extractor to be reduced to a minimum.

Figure 71 illustrates an apparatus in which the combustion products of gas constitute the drying agent. The drying chamber 4, is cylindrical in form. Atomization of the solution is by means of the centrifugal disk, 5, set up in the top cover of the drying chamber. The combustion products obtained from the burning of gas in a furnace, 1, proceed to a mixing chamber, 2, where they are diluted by atmospheric air until reduced to the desired temperature. The gases are then delivered by pipe line to the chamber, partially in the immediate vicinity of the disk, and partially along the periphery of the chamber, through vents, 6, are provided in the side walls of the bottom of the drying chamber, for intake of ambient air. Atmospheric air is taken in to reduce the temperature of the medium at the bottom of the chamber if it is being used to dry heat-sensitive solutions or solutions containing large quantities of sugars, the dry powders of which fuse at elevated temperatures and may then stick to the drier walls. From the bottom of the drying chamber, the powder is removed in suspension in a powerful air blast, along with the used gas. In the cyclone, 8, the powder settles and is dumped through a seal valve to a line in which cold air is blown by a fan. The powder cools in the air current and is finally separated out in another cyclone.

Figure 72 adduces the design of a spray drier for liquid pastes of azo dyes, capable of delivering 200 kg of finished product per hour. The spray drier consists of a vertical, cylindrical, reinforced concrete chamber, 1, with an internal diameter of 4 m and a height of 5 m, mounted on four reinforced concrete columns. The chamber is faced within with 15 mm of asbestos and thin sheets of stainless steel. On the outside, the chamber is covered with 15 mm of plaster.

The suspension, or a liquid paste of the dye is delivered by centrifugal pump, 3, from a tank, 2, to a feed tank, 4, atop the drying chamber. The feed tank has a stirrer and steam jacket. The paste is stirred and heated in this tank. Excess solution returns to tank, 2, by an overflow pipe. The heated paste is delivered from the tank by an inclined pipe, 5, to a distributor disk, 6, caused to rotate by a reduction gear driven by an electric motor. The dried powder settles to the bottom of the drying chamber, from which scrapers, 7, displace it to the discharge outlet, 8, in the chamber floor, which dump it into the escape line, 9, from which it proceeds to packaging by means of a screw conveyor, 10. The products of fuel combustion or the heated air, are fed through an intake, 11, and enter the chamber in immediate proximity to the sprayer. Passing through the drying chamber from the top downward, the dust-laden gases proceed via two air lines, 12, to a cyclone battery, 13, there being a battery on each side of the chamber. Each battery consists of 12 cyclones. Passing through the two batteries successively, where 80 to 85% of the dust is extracted, the gases emerge from the drier through two air lines which then join to form a common air line, 14. The gases move through the ventilator, 15, to a scrubber, 16, with chord packing,

irrigated with water or the dye, where the residual powder is extracted. The gases escape through outlet 17 in the scrubber roof. Before re-entering the atmosphere, the gases again pass through a blower.

From the scrubber, the solution flows to a tank, 18, from which a centrifugal pump, 19, sends it back to the scrubber. This circulation continues until the solution has concentrated to the point at which it can be directed to the spray drier. The dye powder separated out in the cyclones is dumped into hoppers, 20, lined with thin stainless-steel sheeting. The bunkers are kept closed by gates operated by counter-weights. Each of the 41 gates opens automatically and consecutively once per scraper revolution, the scraper revolving 2 or 3 times per minute. The doors are opened by a projection on the scraper which, passing beneath the counterweight, raises it and the door together, permitting the powder in the hopper to fall to the bottom of the chamber. The powder falling out of the cyclones is removed with the rest of the powder in the manner previously described.

Considerable difficulties have been encountered in efforts to design driers to function at high initial gas temperatures (500 to 800°C). The difficulty lay in the fact that in the high temperature zone, it is impossible to use the usual type of metal fabrications, and this complicates gas intake into the chamber, particularly if it is of large diameter.

Figure 73 illustrates a VTI spray installation for drying sulfite caustics by solid fuel combustion products at 500 to 600°C. The spray drier consists of a cylindrical brick tower, 1, with a metal internal drying chamber, 2. The tower, 9 m in height, and

6.3 m in diameter, has a concrete base which rests on reinforced concrete columns. The tower is plastered on the outside. The working height of the drying chamber is 5.2 m and its diameter 4.2 m. The inside of the chamber roof carries 100 mm of gunite. The drying agent is flue gas from the burning of wooden chips and bark in the furnace, 3. The furnace gases move to a spark-after-burner cyclone, 4, which is 1.7 m in diameter, and then at 800-850°C, proceed to the mixing chamber, 5, where they are diluted by atmospheric air until brought down to the required temperature. From the mixing chamber, the diluted gases proceed to the distributor manifold of the drier. This is located in the upper portion of the tower, and from there they move radially, through holes, to the drying chamber. The gas comes through the holes at 10 m/sec. The distributor manifold is of firebrick. The amount of gas delivered to the drier is controlled by means of the gate, 8. The solution is delivered by gravity flow to three pressure nozzles with outside mixing, 9, in which it is atomized by saturated steam at 4 atm excess pressure. The dry powder falling to the bottom undergoes continuous removal from the drying chamber by mechanical scrapers, 10, and proceeds to the cooler, 11. The cooler consists of an empty basement in which there is constant circulation of water. The used gases, with the unprecipitated portion of the dried powder, rise through an aperture at the bottom of the drying chamber, to enter the dust-extracting cyclone, 12. In order to obtain uniform extraction of the gases from the chamber, four such cyclones, each 760 mm in diameter, are installed on the tower. Further separation of the dry powder occurs in the cyclones. The powder is then dumped into the cooling chamber through a pipe controlled by a winker valve, 13. Mechanical scrapers remove the powder from the cooler floor to an exit hole through which it falls

through a slide, 15, to a scoop elevator, 16, which transports it to a bunker, 17. From the bunker, the powder moves to a screw conveyor and then to packaging in paper sacks. The pitch of the screw conveyor threads is varied so as to compress the powder somewhat, thereby raising its volumetric weight.

The used gases, with very fine particles of the powder entrained, are drawn out of the cyclones by two medium-pressure blowers, 18, and are driven to a scrubber, 19, which is 1.79 m in diameter. The gases undergo their final purification in the scrubber. The solution to be dried, which is atomized under three atmospheres excess pressure by mechanical percussion nozzles designed by the VTI 20, is employed to extract the dust. The scrubber has a drain tube through which a portion of the solution is constantly returned to the tank, 21, by gravity.

In operation, this installation has been found to permit considerable intake of atmospheric air through the tower masonry, and a somewhat uneven distribution of gases across the diameter of the chamber. In more recent VTI spray driers, the gases are removed at the center of the drying chamber, which permits uniform gas distribution across the chamber section. In addition, the drying tower is of welded metal construction.

Organic solvents are often most rationally evaporated in superheated steam. Thus, solvents presenting the danger of explosion may be dried in an inert medium, and the overall equipment is economical. Figure 74 illustrates such an installation.

The solution out of which the organic solvent evaporates on drying, enters a surface-of-contact heat exchanger, 1, where it is heated by steam to the highest possible temperature, and is delivered

to a centrifugal disk, 2, by which it is atomized. The disk is caused to rotate by a motor, operating through reduction gear passing through the drying chamber roof. The drying chamber, 3, is a cylindrical tower. Superheated steam is admitted to it from above, at a temperature of 150 to 500°C, depending upon the properties of the solution to be dried and the liquid being evaporated (the solvent). The particles of solution, interacting with the superheated steam, dry off, and most of them fall to the bottom of the drying chamber. The powder product is removed from the chamber continually by mechanical scrapers, 4, or by brushes, through special seals. The mixture of water vapors and organic solvent in superheated condition goes to the cyclone, 6, with the fine particles of product. The dry product is separated out in the cyclone. Further, the vapors of water and solvent proceed to a tubular heat exchanger, 7, where they are condensed in part. The heat lost in condensation goes to evaporate water entering from the separation chamber, 9. The condensates formed from water and solvent go to the heat exchanger, 8, in which the vapor cools and condenses completely.

Water is the coolant used. The condensates of water and solution are also delivered to the heat exchanger from the separation chamber. In this chamber the solvent, as the heavier component, settles to the bottom, the water being on top.

From the separation chamber, the solvent returns to the process, and the water goes to the heat exchanger and evaporator, 7. A turbine blower sets up a sufficient vacuum above the surface of the water in the evaporator to bring the boiling point to a level below the dew (condensation) point of the mixture of steam and solvent. The turbine blower compresses the saturated steam to a

pressure slightly higher than one atmosphere in order to overcome the resistance of the path traversed as the steam mixture progresses through the equipment. The turbine blower delivers the compressed water vapor to the superheater, 11, and then to the drying chamber. The vacuum in the condenser may also be set up by the vapor-flow compressor, 12.

This design is rendered economical by its use of the heat of condensation of the mixture of water and solvent vapors after drying, and by the complete reuse of the solvent.

Drying Chamber

It is clear from the spray drier designs described above that there is now available a large number of drying chambers of designs differing in accordance with the drying procedure and the nature of the solution to be dried. Cylindrical drying chambers are the type most widely used in industry.

Drying chambers are usually made of metal, as this prevents harmful intake of atmospheric air. Sometimes, for drying with gases at low temperature, the chambers are made of concrete, brick or, in rare cases, wood. In spray drying, the condition of the inside surface of the chamber is a factor of high importance. In order to prevent dry particles from settling on the walls, the walls must be smooth, and have neither projections nor chinks. Powder settling on the chamber walls becomes overheated and spoils. With certain solutions, this may result in the product catching fire, or even in an explosion. The inside of the chamber is faced with tile for drying foods or pharmaceuticals, and, for the accomodation of low gas temperatures. Sometimes the inside of the chamber is faced with sheet aluminum, zinc-plated iron, or thin, rustproof steel

sheets. This is standard procedure in the drying of food, pharmaceuticals, and certain chemical solutions. Ordinary sheet steel, with no special facing, is used in chambers for the drying of a broad range of solutions. Illumination is usually provided within the chamber, and windows are provided through which the nozzle and scraper operation, and the cleanliness of the walls, may be checked. If highly flammable or explosive products are to be dried, the windows should be so placed as to permit ready observation of the entire interior of the chamber. In designing spray driers, much attention must be given to making sure that it is impossible for the powder to accumulate at any point along the route of the dust-laden gases. In addition, it is essential that this path be readily accessible in its entirety for the complete removal of the powdered product when the sprayer is stopped.

The unit capacity is a problem that gets much attention in design. Years of experience with spray driers have shown that unit cost for heat and power per kilogram of liquid evaporated declines with increase in the capacity of each drying unit, and the entire drying process is more efficient. Larger capacity per unit also means lower relative construction costs and fewer operating personnel. One advantage of spray drying over other types lies in the fact that each unit is capable of handling a larger amount of solution to be dried. The maximum dimensions of the drying chamber or, in other words, the maximum capacity of the unit, is basically determined by the possibility of obtaining uniform distribution of gases and atomized solution across the section of the chamber.

Drying chambers are currently being made with diameters of up to 10 m, and heights of up to 25, while the distribution of

gases and solution across the section of such driers is of adequate uniformity.* In the drying of concentrated solutions with high initial gas temperature, the maximum possible productivity per unit is sometimes governed by the method of spraying used. Thus, with centrifugal disks or platter-type pressure nozzles, the maximum capacity per unit depends on the maximum capacity of the spraying equipment. For example, the disks now in existence permit the spraying of up to 6,000 kg of solution per hour. This is the limit of the capacity of the drier. The situation is different if mechanical or pressure nozzles with tangential compressed air or steam intake are used. In this case, the number of nozzles needed are determined by the productivity of the drier desired. In other words, the productivity of the spraying equipment does not govern that of the installation as a whole.

The Drying of Certain Materials

Spray drying is presently extensively used in the drying of certain materials. In the food industry it is used to dry milk, eggs, albumin, various juices, sweet cream, syrups, tomatoes, raw and cooked potatoes, coffee and tea extracts, and preparations of cocoa, serum, children's-grade milk, etc. A large amount of various solutions are dried in atomized form in the pharmaceutical and chemical industries. Let us illustrate by citing the methods used to dry certain solutions.

Drying Eggs

The white, the yolk, or the white and yolk together, may be dried by spraying. Centrifugal disks or mechanical nozzles at 150 atm are used. Hot air or gas combustion products are used as drying agents. When the equipment is operated on the parallel current

principle, the gas temperature before drying may be near 175°C. A high-quality product is obtained. The moisture content of the egg powder after drying is 3 to 5%. However, the terminal moisture content is sometimes reduced to 1% by supplementary drying in a current of dry air heated to 75°C, in order to permit longer preservation. After drying, the egg powder is cooled to 30°C by air at a temperature of 24°C. According to the literature, the quality of the product is improved if the solution be cooled to 4 or 5°C before spraying. Preliminary thickening of the solution in a scrubber is not employed, due to its high viscosity and the impairment of the quality of the product.

Drying Milk

Whole, skim, or condensed milk may be dried. Milk may also be dried with special additives (vitamins, sugar, etc). Centrifugal disks of mechanical nozzles are employed for atomization. Drying is by means of heated air with an initial temperature of 130-140°C.

Parallel motion of the air and the particles of solution is best. A wet scrubber is used as the last stage in stripping the gases, for preliminary condensation and powder extraction. The volumetric weight of the powder is increased by deaerating the solution before it goes to the spray apparatus. Figure 66 illustrates one of the types of equipment used in industrial drying of milk.

Drying Albumin

Food albumin is dried by hot air at an initial temperature of 130-140°C, and a terminal temperature of 80°C. Industrial albumin

is dried at initial temperatures of up to 180°C. The drying agent may either be hot air or the products of combustion of gaseous or low-ash solid fuels. In this case, it is essential that parallel flow of the gas and solution in the drying chamber be maintained. The albumin may be atomized by centrifugal disks or mechanical nozzles.

Drying Bone Glue

Studies at the drying laboratory of the VTI (29) have shown that spray dr ing constitutes the best practice in drying bone glue. It reduces power consumption by ½ or 2/3, relative to the other methods now in use, depending upon the method of spraying employed. Fuel consumption is cut by 3/4, and the annual output of dry glue per cubic meter of plant space, by 5/6. This method of drying proceeds as follows. After steaming and addition of sulfur dioxide as a preservative, the concentrated bouillon, containing 45 to 50% moisture and having a temperature of 50 to 60°C is delivered to the spray process. This may be performed either by mechanical nozzles at 80 to 100 atm or by a centrifugal disk. A satisfactory drying agent is provided by the gases of anthracite coal or wood fired in a special oven. The gas temperature ahead of the drier is 350 to 400°C. The drying chamber works on the parallel current principle. The dry glue is briquetted as slabs. A water-irrigated scrubber is used as the third stage in gas purification. A 7 to 8% bouillon concentrate emerges from the scrubber, and is delivered to vacuum vaporizers.

Drying Calcium Chloride

A solution of calcium chloride with an initial moisture content of 68% is dried by hot air with an initial temperature of

300 to 320°C. The air is heated in a gas heater. The solution is atomized by compressed air in pressure nozzles. The drying chamber works on the parallel current principle. The calcium chloride is dried to 10% moisture content. Centrifugal cyclones are used for the first stage cleaning of the gases, and the second stage is a wet scrubber in which the solution to be dried is atomized. The load per unit volume of chamber, measured in evaporated moisture, is 10 $kg/m^3/hr$. It should be noted that greater economy is obtained by atomizing calcium chloride (true solution) by mechanical nozzles.

Drying Sulfite Caustics

Sulfite caustics, after preliminary condensation in strippers, enter the drying process with an initial moisture content of 50%. Sulfite caustics may be burnt, but in spray driers they are dried at an initial gas temperature of 500 to 600°C. Products of wood waste and bark combustion are used as the drying agent. Sulfite caustics are atomized with outside-mixing pressure nozzles employing saturated steam at 4 atm excess pressure. The resultant powder has 2 to 3% moisture at a gas temperature of 130-135°C, below the drying chamber. Cyclones and a wet scrubber are used to extract the powdered product from the flow of gases. The scrubber serves not only to purify the gases, but also as a heat-consumer, in which the sulfite caustics are atomized. Figure 73 shows the VIT industrial-scale apparatus for use with this solution. The load per unit volume of drying chamber measured in evaporated moisture is 12.5 to 13.5 $kg/m^3/hr$.

The success that has been obtained with industrial drying of an organic solution (sulfite caustics) at a higher rate, testifies to the great possibilities for increasing the productivity of the

existing spray dryers and the introduction of high-temperature processes in the drying of other solutions.

Drying Orange Juice

Orange juice is exceptionally sensitive to heat, and a considerable proportion of its vitamin content is lost in drying under the previously standard procedures. This juice dries well in a spray drier in vacuum. The orange juice is first condensed to 50% moisture in vacuum vaporizers at 10 mm Hg residual pressure. The condensed solution is delivered to a spray drier (Figure 75a) operating intermittently. The drier is a cylindrical chamber 1.8 m wide and 7.5 m high. Mechanical nozzles and scrapers are housed on a rotating axis within the chamber. The equipment functions as follows. A diffusion pump creates a vacuum in the chamber, leaving a residual pressure of 0.3 to 0.4 mm Hg. The concentrated solution is atomized by the pump, with the aid of mechanical nozzles, after the required vacuum has been set up in the chamber. Atomization is accompanied by intensive evaporation, with the result that the pressure in the chamber rises to 1.8 mm Hg (Figure 75b). The moist product precipitates on the vertical chamber walls, where it is dried to a determinate final moisture content (1-2%). The chamber walls are heated to 50-55°C by water. Uniform distribution of the moist product throughout the chamber on atomization is obtained by rotating the nozzles around a vertical axis. The pressure in the chamber is reduced to 0.5-0.6 mm Hg during the drying of the moist product remaining on the chamber walls. After the product has been dried, it is cleaned away by scrapers. The dried product is removed from the chamber through a seal valve to a receiving tank, and then is packaged in glass. The air is maintained at 12% humidity in the packing shed. This equipment can produce 95 kg of dry powder per

hour. Figure 75c shows the change in the mean rate of drying per square meter of internal drying chamber surface relative to the terminal moisture of the powder and the specific load on the chamber surface (the thickness of the layer of wet powder on the chamber surface).

Determination of Optimum Drying Practice

By drying practice in spray driers is meant the temperatures maintained, the moisture of the gases and their pressure, the method of atomization, the motion of the drying agent and the particles of solution in the drying chamber, the velocity of the gases, etc. That practice is regarded as optimal in which the finished product has the required physical chemical properties, and the effectiveness of the drying process is at its maximum. In order to find a correct approach to the determination of optimum drying practice, it is necessary to give attention to those properties of the product which may show variation within fairly wide limits during spray drying. These properties include, to begin with, the volumetric weight of the powder, particle size and distribution, particle structure, etc.

Volumetric weight is the most important characteristic of the product. Determination of its magnitude usually is dependent on considerations of engineering and economy, including the type and cost of packaging, transportation costs, etc.

The volumetric weight of the powder is determined by its moisture, the fractional composition of the powder, the structure of the particles, and their surface state. Particle structure is of particular importance in determining volumetric weight.

The drying of colloidal hydrophilic solutions very often produces hollow particles. In this situation, the volumetric weight of the powder will be very low. On the other hand, when hydrophobic colloidal solutions and suspensions are dried, the particles emerging are usually solid, and high in specific gravity, with the result that the volumetric weight of the powder is higher.

The external surface of the particles also differs with the solution to be dried. The surfaces of the particles obtained by the drying of hydrophilic colloidal solutions are usually level and smooth. When true solutions of inorganic substances and suspensions are dried, the surface is uneven, and the particles themselves are spongy. Consequently, the volumetric weight of the resultant product depends upon the molecular structure of the solution being dried. As a rule, the volumetric weight of hydrophilic colloidal solution powders is lower than that obtained from other types of solutions. The dispersion of the powder affects the volumetric weight. As particle size declines, the volumetric weight of the powder increases up to a certain point. Volumetric weight also increases with rising diversity in grain size composition, as the particles pack better, less free space remaining between them.

The initial concentration of solution has a pronounced effect on the volumetric weight of the resultant product. In the majority of cases the volumetric weight of the powder rises with increase in the concentration of solution. This occurs with meat bouillon, inorganic salts, dyes, milk, coffee extract, and tannin. However, there are certain hydrophilic colloidal solutions in which the volumetric weight sometimes declines. This is probably explained by the fact that with such solutions, the viscosity of the solution increases to a greater degree as the concentration rises. This

produces a coarser spray and, as a result, a powder of reduced volumetric weight.

Noncondensing gases, such as air, found in the initial solution, affect the volumetric weight of the powder. Therefore, aeration of the solution makes possible reduction in the volumetric weight of the powder. Vice versa, deaeration before drying yields a powder of greater volumetric weight. It is to be noted that the presence of air in the solution is not the reason for the formation of hollow particles.

The temperatures maintained during drying are of particular significance in determining volumetric weight, particularly in the drying of hydrophilic colloidal solutions. The greater the intensity of evaporation during the first period due to increase in gas temperatures, the greater the expansion of particles of hydrophilic solutions. As the gas temperature rises, with parallel flow, the volumetric weight of the powders obtained on drying true solutions also declines, although to a lesser degree than in the drying of hydrophilic colloidal solutions. In the drying of hydrophobic suspensions, the temperature maintained in drying has negligible effect on the volumetric weight of the product. Within the limits of variation of initial gas temperatures to 160°C, the volumetric weight of the powder undergoes insignificant change. When the gas and the particles of solution move in counterflow, the resultant powder is of greater volumetric weight than in parallel flow.

The volumetric weight of the powder may change due to the temperature of the solution. With most solutions, an increase in temperature results in a rise in the volumetric weight of the product. This is explained by the fact that as the temperature of

a solution rises, its viscosity declines. As a result, the spray is more highly dispersed, all other conditions being equal.

Sometimes, modification of drying practice fails to yield a finished product of the required volumetric weight. In such cases, a variety of methods are used to raise the volumetric weight of the powder after drying. The method most generally used is to grind the powder at the moment of emergence from the drier or to compress it in screw conveyors of varying pitch. Thus, the volumetric weight of sulfite caustic powder consisting of hollow particles is multiplied three-fold on grinding in a ball mill. Sometimes, the powder is briquetted to raise its volumetric weight after drying. It is to be noted that for purposes of storage, briquettes are more convenient than powders. This is explained by the fact that powder has a larger surface area, causing it to take up moisture more rapidly in storage, with the result that various destructive biochemical reactions occur more intensively therein.

Under certain conditions, special substances, most frequently solutions of inorganic salts (e.g., table salt), are added to the starting solution to raise its volumetric weight.

The dispersion of the powder affects not only its volumetric weight, but its solubility, color, and free-pouring properties. Large particles are colored more solidly and brightly than are small particles. The greater the particle, the more free-flowing the powder. As particle size declines, the time required to dissolve the powder also declines. Thus, we see that spray drying permits modification of certain of the physical chemical properties of the product in accordance with the drying practice.

The choice of drying practice is determined by the technical specifications for the finished product, and the economic indices for the functioning of the apparatus.

In seeking the best method of spraying, the first factors to be considered are the physical chemical properties of the solution, and considerations of economics and engineering. Mechanical spraying is the most economical method; pressure spraying the most expensive. However, not all solutions are subject to atomization by mechanical nozzles. For example, hydrophobic suspensions and high-viscosity solutions are incapable of atomization. It should be noted that, where hydrophilic colloidal solutions are concerned, viscosity declines with increase in pressure. In mechanical atomization of heat-stable solutions it is helpful, under certain conditions, to heat the solution to the maximum temperature possible before atomization. The heating of the solution should take place after it has passed through the pump. This permits the attainment of a high degree of dispersion of the spray, and very intensive evaporation. Let us take, for example, a solution atomized at 100 to 150 atm. The boiling point of the solution at this temperature is 300 to 340°C, so that the solution, preheated to 250 or 300°C, converts to steam instantaneously on atomization (for the most part). Drying under these conditions will be at maximum economy.

Up to the present, the effect of high-pressure atomization of a solution upon its properties has not been clarified. Certain literature sources state that proteins undergo partial denaturing under high-pressure atomization. The concentration of solution affects the functioning of the spray apparatus, the economic indices of the drying process, and the density of the resultant product. The volumetric weight of the powder increases with increase in the

concentration of the solution. When solutions are dried in concentrated form, the drying chamber does not have to be as high, the fuel consumption is lower, recovery of a higher percentage of powder from the gases is easier, and there are other advantages. Therefore, from the viewpoint of economics, concentrated solutions are the easiest to dry. The maximum concentration that can be used is the highest at which the pumps can function. In certain situations, where very highly-concentrated colloidal solutions are to be dried, the solubility of the powder or finished product undergoes a reduction during centrifugal atomization or pressure nozzle spraying, and emerges, as a result, not as powder, but as a matted material. This greatly complicates the removal of the dry product from the drying chamber, and the extraction of the dust from the gas flow.

The engineering economics of the spraying of solutions by the various available methods have already been presented in Chapter IV.

Determination of the temperature conditions for drying is usually governed by the heat sensitivity of the solution to be dried. If the solution is completely insensitive to heating, the temperature is usually governed by the structure of the finished product. The higher the initial temperature of the gases, the more economical the drying process. When the gases and the particles of solution in the drying chamber move parallel to each other, as shown in Chapter V, high gas temperatures may be provided without doing damage to the properties of the end product. In addition, as we have previously noted, the resultant product is more uniform. Consequently, when drying heat-sensitive solutions, the most logical procedure is to use only parallel flow of the sprayed solution and the gases. Drying equipment for the food industry has to be based on this

principle in the majority of cases. In the drying of certain food products, gases (or air) at an initial temperature of up to 300°C may be used without reduction in quality.

The temperature of the gases after the drier is between 75 and 150°C. If the gas temperature is below 75°C, there is a sharp drop in intensity of drying, and it is difficult to obtain a product of low terminal moisture.

In addition, if the temperature is too low, the gases may cool to the dew point en route from the drier to the dust-extracting apparatus. Under these conditions it is impossible to use cloth filters to extract the powder, as they clog rapidly.

The optimal temperature for the used gases is usually established by experiment. In this regard it is to be remembered that when a drier operates on parallel flow, the temperature of the particles is determined mainly by the temperature of the escaping gases. Consequently, the higher the temperature of the gases, the higher the temperature of the powder after drying. The lower the terminal moisture content of the product, the closer these concepts correspond to reality. When heat-sensitive solutions are dried to a low terminal velocity, it is sometimes more logical not to dry the powder to its final moisture content. This makes it possible to bring the exhaust gases and consequently, the dry product, down to a low temperature. When this is done, the final drying of the powder is done with fresh dry hot air, during pneumatic transport, when the powder is in suspension.

The exhaust gas temperature is sometimes set somewhat higher so as to reduce the dimensions of the drying chamber. This type of procedure may also be economical if the gases then go to the

wet scrubber, in which preliminary condensation of the solution to be dried takes place.

The terminal temperature, or the gas temperature after the drier, is extremely sensitive to changes in the rate of flow of solution through the spray equipment, and to the quantity and initial temperature of the gases. In addition, the slightest variation in these variables produces a rapid change in the terminal temperature of the gases, as the particles of solution are in the drier only for a matter of seconds, on the average. Therefore, in spray drying, the delivery of solution to atomization is regulated only in terms of the terminal gas temperature. Thus, if the terminal gas temperature rises above the desired level, the quantity of solution delivered for atomization is increased, and vice versa. Regulation of the drying process in terms of terminal gas temperature also makes it possible to obtain a product that meets the desired specifications both as to moisture and other indices of quality. The starting temperature and the quantity of gas are more stable parameters in drying than the amount of solution atomized.

In the spray drying of certain solutions, cooling of the dried product is often employed. This includes products which fuse with heat, and, in the food industry, products containing sugar. In addition, as shown by the latest data, the quality of the product after drying is considerably improved if it is cooled rapidly. In reality, therefore, oxidation, denaturing of proteins, etc., is dependent not only on the absolute temperature of the product, but on the length of time during which this temperature is applied. It is therefore sometimes less dangerous in terms of preserving the physical-chemical properties of the product, to permit it to be heated for a brief period to a higher temperature

than to keep it hot for a longer period but at a lower temperature. The usual method of cooling the product is by introducing cold gases in the lower zone of the drier or to air-dry it during pneumatic transportation from the drier to the powder-extractor. The product may also be cooled by contact, i.e., by removal from the drier with the aid of scrapers, when the bottom of the chamber is used as a cooler. Figure 76 illustrates a cooler functioning with a system of closed circulation. The powder goes from the drier to the upper platter, 1, and, drifting down from it, falls to the bottom of the cooler chamber, 2. Cold air moves countercurrent to the falling powder. This air undergoes cooling in the surface-contact heat exchanger, 3, provided with water or a special brine. Air circulation is by means of a blower, 4. Seal valves, 5, are provided at the powder inlets and outlets.

The method of determining the procedure to be used in removing the powder from the drying chamber, the system of dust extraction, and the heat sources, are all adduced in Chapters VI and VII.

Sample Analysis of a Spray Drier

The analysis of a spray drier amounts, essentially, to determining the volume of the drying chamber and the basic equipment needed.

The most difficult problem in heat analysis of a drier is determination of the basic dimensions of the drying chamber. The chamber diameter is determined on the basis of the diameter of the spray, the governing consideration being to prevent the particles of spray from reaching the walls or the chamber before drying. In atomization with a single nozzle or centrifugal disk,

the chamber diameter must be equal to or slightly less than the maximum diameter of the spray. With 3 or more nozzles, the distance between them is less than the maximum diameter of the spray, as the maximum density of the current of solution is at its center, and undergoes a symmetrical decline toward the edges. If the nozzles are set at some angle to the horizontal, the chamber diameter is based on the flight distance of the particles.

In determining the chamber diameter it is also necessary to bear in mind that the average velocity in the drying chamber, when the currents of gas and particles of solution are parallel or mixed, must be within the range of 0.2 to 0.5 m/sec. Particular care must be given to determining chamber diameter when atomizers are used whose spray is in the horizontal plane, i.e., in atomization by centrifugal disks, when it is difficult to change the diameter of the spray at given rate of flow and dispersion.

Once the required diameter of the drying chamber has been determined, its height is determined from the chamber volume calculated by equation (V-30). If the spray is in horizontal position, the height-to-diameter ratio of the chamber is close to 1:1. If the spray points downward, the height of the drying chamber is greater than its diameter. Concurrently, the lower the concentration of the solution, the greater the height of the drying chamber.

The method of choosing and analyzing the basic drier equipment has been adduced in the preceding chapters.

The successive procedures involved in analysis of a spray installation are most readily followed by a concrete example, which we shall now adduce.

The starting specifications for design are usually the hourly production rate of dry product desired, the moisture content of the product, and the moisture content of the initial solution. The temperatures to be maintained in various phases are based on experimental data.

Technical Design Specifications

1. The solution is a true solution. The maximum temperature permissible during the drying process is 110°C.

2. The hourly output of dry product, G_1, is 400 kg.

3. The initial and terminal moisture content of the solution and the product, designated as w_1 and w_2, are, respectively, 64.3 and 5%.

4. Air is to be used for dyring.

5. The initial temperature of the air ahead of the drier, t_1, is 300°C, and the air temperature behind the drier, t_2, is 100°C. Under these conditions, the drier should have the solution and air currents in parallel flow.

The process flow shown in Figure 77a has been decided upon to dry the given solution. The air is heated in a gas heater. The best method of atomizing the solution is by mechanical nozzles. The powder is extracted from the drier by scrapers. The final stripping is in a wet scrubber irrigated by the solution. The thermal analysis of the apparatus is based on winter conditions.

Thermal Analysis of the Equipment

Balance of Materials in the Drier

In accordance with the process to be used, we calculate that preliminary condensation of the solution will take place in the drier, to a moisture content, $w_1' = 60\%$, which then undergoes drying from $w_1' = 60\%$ to $w_3 = 5\%$.

The amount of solution atomized in the drier is

$$G_1' = G_2 \frac{100 - w_2}{100 - w_1'} = 400 \frac{100 - 5}{100 - 60} = 950 \quad \text{kg/hr}$$

The total amount of solution dried is

$$G_1 = G_2 \frac{100 - w_2}{100 - w_1} = 400 \frac{100 - 5}{100 - 64{,}3} = 1065 \quad \text{kg/hr}$$

The hourly output of the drier in absolutely dry product is

$$G_{cv.x} = 0{,}95 \cdot 400 = 380 \quad \text{kg/hr}$$

The total moisture evaporated in the installation is

$$W = G_1 - G_2 = 1065 - 400 = 665 \quad \text{kg/hr}$$

The amount of moisture vaporized in the drier is

$$W_1 = G_1' - G_2 = 950 - 400 = 550$$

Plotting the Drying Process on an I-d Diagram

Drying is performed by means of ambient air having the following parameters:

$$t_0 = -10^\circ\text{C}; \qquad d_0 = 1{,}47$$
$$\varphi_0 = 80\%; \qquad I_0 = 1{,}53$$

The starting point, B, of the drying process, will have the following parameters: $t_1 = 300^\circ$ and $d_1 = d_0 = 1.47$ g/kg (Figure 77b).

Let us determine the heat loss in the drier per kilogram of moisture evaporated.

The heat expended upon heating the product is:

$$q_м = \frac{G_2 c_м (\vartheta_2 - \vartheta_1)}{W_1} = \frac{400 \cdot 0{,}335\,(90 - 48)}{550} = 11{,}7 \quad \text{kcal/kg}$$

in which c_m is the thermal capacity of the product, equal to:

$$c_м = c_{dry} \frac{100 - w_2}{100} + \frac{w_2}{100} = 0{,}3\,\frac{100 - 5}{100} + \frac{5}{100} = = 0{,}335 \quad \text{kcal/kg/}^\circ\text{C}$$

in which

c_{dry} is the thermal capacity of the absolutely dry product, which is 0.3 kcal/kg/°C; ϑ_2 is the temperature of the product after drying, 90°; ϑ_1 is the temperature of solution, which is taken as being that shown on a wet-bulb thermometer at the corresponding air parameters in the scrubber, with allowance for cooling by 1°C, i.e., 48°C.

Given appropriate insulation of the drier, let us take the loss of heat to the surrounding medium as q_5, or 60 kcal/kg, in which case the total heat losses will be:

$$\Delta = \vartheta_1 - q_м - q_5 = 48 - 11{,}7 - 60 = -23{,}7 \quad \text{kcal/kg}$$

Let us plot the actual drying process on an I-d diagram (see Figure 77b). Now let us determine segment Ee:

$$Ee = ef\frac{\Delta}{m} = 100\,\frac{-23{,}7}{500} = -4{,}8 \text{ мм.}$$

Let us draw from point B, through point E, a straight line to intersection with t_2 = 100°C, giving us the moisture content of the used air as d_2 = 70 g/kg.

The consumption of dry air per kilogram of moisture vaporized is:

$$l = \frac{1000}{d_2 - d_1} = \frac{1000}{70 - 1{,}47} = 14{,}6 \quad \text{kg/kg}$$

The hourly consumption of dry air is

$$L = lW = 14{,}6 \cdot 550 = 8050 \quad \text{kg/hr}$$

The specific volume of the moist air per kilogram of dry air is

$$v_0 = 4{,}64 \cdot 10^{-6}\,(622 + d)\,(273 + t);$$

while at the drier input v_0' is 1.65 m^3/kg, and at the drier output v_0'' is 1.19 m^3/kg.

Determining the Major Dimensions of the Drying Chamber

Let us use one Grigor'yev-type mechanical nozzle to atomize the solution. Assuming the geometrical dimensions of the nozzle to be as needed, let us take the coefficient of discharge as $\mu = 0.6$. Then, in atomization at a pressure of 100 atm, the diameter of the exit section of the nozzle will be:

$$\delta_0 = \sqrt{\frac{G_1}{0{,}785\,\mu\sqrt{\frac{2g\,\Delta p}{\rho_p}}}} = \sqrt{\frac{2{,}4 \cdot 10^{-4}}{0{,}785 \cdot 0{,}6\sqrt{\frac{2 \cdot 9{,}81 \cdot 99 \cdot 10^4}{1100}}}} = 1{,}95 \cdot 10^{-3} = 1{,}95 \text{ мм},$$

in which G_1 is the amount of solution atomized, in m^3/sec, and ρ_p is the unit weight of the solution, 1,100 kg/m^3.

According to experimental data, the maximum diameter of the spray is 3.5 m. Let us then take the diameter of the drying chamber, D_K, as 3.5 m.

The average air velocity in the chamber is

$$u = \frac{4\,(v_0' + v_0'')\,L}{3600 \cdot 2\,\pi\,D_\kappa^2} = \frac{4\,(1{,}65 + 1{,}19)\,8050}{3600 \cdot 2 \cdot 3{,}14 \cdot 3{,}5^2} \approx 0{,}3$$

which satisfies the major specifications for operation of the drier.

Let us determine the mean temperature differential between the air and the surface of the solution.

During the first stage of drying, the temperature of the surface is equal to that shown by the wet-bulb thermometer, $\vartheta_n = t_m$ [illegible].

This period continues until the moisture of the particles becomes equal to the hygroscopic, which means, for the solution in question, w_2^c = 40% (moisture content relative to absolutely dry weight).

The amount of moisture vaporized as the moisture content of the particles in the solution is reduced from w_1 to w_2, is:

$$W_1 = G_1' \frac{w_1 - w_2}{100 - w_2} = 950 \frac{60 - 28.6}{100 - 28.6} = 427 \quad \text{kg/hr}$$

The moisture content of the air at the end of the first period of drying is

$$d_2' = d_1 + \frac{1000\, W_1}{L} = 1.47 + \frac{1000 \cdot 427}{8050} = 54.5 \quad \text{grams/kg}$$

A moisture content of 54.5 g/kg is the course of the process actually under way (point D) corresponds to an air temperature of t'_2 = 150°C. Thus Δt_1 becomes

$$\Delta t_1 = \frac{t_1 - t_2'}{2.3 \lg \dfrac{t_1 - t_м}{t_2' - t_м}} = \frac{300 - 150}{2.3 \lg \dfrac{300 - 53}{150 - 53}} = 160°.$$

Assuming that when w_2^c = 40% the temperature of the surface of evaporation is $\vartheta_1 = t_m$ = 53°C, while at the moisture of equilibrium w_p^c = 2% the temperature of the product will, in accordance with equation (V-34), be ϑ_2 = 90°.

The average temperature differential Δt_2 during the second drying period is:

$$\Delta t_2 = \frac{(t_2' - t_м) - (t_2 - \vartheta_2)}{2.3 \lg \dfrac{t_2' - t_м}{t_2 - \vartheta_2}} = \frac{(150 - 53) - (100 - 90)}{2.3 \lg \dfrac{150 - 53}{100 - 90}} = 38°.$$

The ratio between the first and second drying periods is

$$X = \frac{1}{1 + \dfrac{(t_2' + t_2)(w_1^c - w_z^c)}{(t_1 + t_2')(w_z^c - w_p^c)\, 2{,}3 \lg \dfrac{w_z^c - w_p^c}{w_2^c - w_p^c}}} = \frac{1}{1 + \dfrac{(150 + 100)(150 - 40)}{(300 + 150)(40 - 2)\, 2{,}3 \lg \dfrac{40 - 2}{5{,}3 - 2}}} = 0{,}62,$$

The average difference in temperature between the air and the surface of evaporation is

$$\Delta t_{cp} = \Delta t_1 (1 - X) + \Delta t_2 X = 160 \cdot 0{,}38 + 28 \cdot 0{,}62 = 84{,}3^\circ.$$

Now let us calculate coefficient of heat exchange by volume.

Let us assume the average volumetric-superficial diameter of a drop to be $\delta_{3.2}$ = 80 mk. The average rate of hovering fall of the drop is

$$u_в = \frac{1}{18} \cdot \frac{\delta_{3,2}^2 (\gamma_p - \gamma_z) g}{\nu \gamma_z} = \frac{1}{18} \cdot \frac{(0{,}08 \cdot 10^{-3})^2 (1100 - 0{,}733)\, 9{,}81}{36 \cdot 10^{-6} \cdot 0{,}733} = 0{,}15 \text{ м/сек}$$

in which ν_1 is the kinematic viscosity of the air, $36 \cdot 10^{-6}$ m/sec^2, at average air temperature, and γ_2 is the average density of the air, equal to

$$\gamma_z = \frac{1 + \dfrac{d_{cp}}{1000}}{v_0^{cp}} = \frac{1 + \dfrac{1{,}47 + 70}{2 \cdot 1000}}{\dfrac{1}{2}(1{,}19 + 1{,}65)} = 0{,}733$$

The coefficient of heat exchange by volume is

$$a_v = 1{,}58 \cdot 10^{-3} \frac{\lambda G_1}{\gamma_p F_K} \left(\frac{1}{\delta_{3,2}}\right)^{1,6} \left(\frac{1}{u_в + u_z}\right)^{0,8} = 1{,}58 \cdot 10^{-3} \frac{3{,}2 \cdot 10^{-2} \cdot 950}{1100 \cdot 9{,}62} \left(\frac{1}{0{,}08 \cdot 10^{-3}}\right)^{1,6} \left(\frac{1}{0{,}3 + 0{,}15}\right)^{0,8} \approx 31$$

in which λ is the average thermal conductivity of the air, or $3.2 \cdot 10^{-2}$ kcal/m/hr/$^\circ$C, and F_k is the cross-sectional area of the chamber, 9,62 m^2.

The heat transferred by the air to the particles of solution is

$$Q = W(595 + 0{,}47\,t_2 - \vartheta_1) + c_ж G_2(\vartheta_2 - \vartheta_1) = 550(595 + 0{,}47 \times \times 100 - 48) + 0{,}335 \cdot 400(90 - 48) = 331\,600 \text{ kcal/hr}$$

The volume of the drying chamber is

$$V_к = \frac{Q}{a_v \Delta t_{cp}} = \frac{331\,600}{31 \cdot 84{,}3} \approx 126 \text{ м}^3.$$

The height of the drying chamber is

$$H_к = \frac{V_к}{F_к} = \frac{126}{9{,}62} \approx 13 \text{ м}.$$

Design of Cyclone-Type Dust Extractors

We shall use an NIIOGAZ TsN-15 cyclone for purposes of dust extraction. Taking off from structural considerations, let us set up 4 cyclones. Then, taking $\Delta_p/\rho_g = 75$, let us calculate its diameter on the formula

$$D_ц = 0{,}536 \sqrt[4]{\frac{V_1^2 \rho_г \xi}{\Delta p}} = 0{,}536 \sqrt[4]{\frac{0{,}655^2 \cdot 105}{75}} = 0{,}526 \text{ м},$$

in which V_1 is the amount of air passing through a single cycline in m^3/sec.

$$V_1 = \frac{Lv_0''}{4 \cdot 3600} = \frac{8050 \cdot 1{,}19}{4 \cdot 3600} = 0{,}665 \text{ m}^3\text{/sec}$$

Let us take the diameter of the cyclone to be 0.52 m. In that case its resistance will be

$$\Delta p_ц = \xi \frac{\rho_г u_v^2}{2g} = 105 \frac{0{,}9 \cdot 3{,}1^2}{2 \cdot 9{,}81} = 46 \text{ mm water column}$$

in which u_v is the nominal velocity of the air in the cyclone, 3.1 m/sec.

Scrubber Analysis

Let us estimate the volume of air leakage into the line from

drier to blower as 10%. In that case, the amount of air passing through the scrubber is

$$L_{sc} = 1{,}1\,L = 1{,}1 \cdot 8050 = 8855$$

The parameters of the air leaking into the line from the building are $t'_o = 20^o$, $\phi'_o = 80\%$. $d'_o = 12$ g/kg.

By plotting on an I-d diagram, the process whereby the used drier air and the air from the building become intermixed, we derive the parameters of the air ahead of the scrubber, which are $d'_{ck} = 64$ g/kg and $t'_{ck} = 93^o$ (point M, Figure 77b).

Let us project the actual process whereby the solution becomes concentrated in the scrubber. In accordance with the analysis of the analogous drying process, this is expressed by the line MM'. In determining the end point of the process, let us proceed from the relative humidity after the scrubber, $\phi_{sc} = 60\%$. The air parameters at point M' are $d''_{sk} = 77$ g/kg, $t'_{sk} = 62^o$.

The amount of moisture vaporized in the scrubber is

$$W_{sc} = \frac{L_{sc}}{1000}(d''_{sc} - d'_{sc}) = \frac{8855}{1000}(77 - 64) = 115$$

The moisture content of the solution after the scrubber is

$$w'_1 = \frac{G_1 - G_2 - W_{sc}}{G'_1 - W_{sc}}\,100 = \frac{1065 - 380 - 115}{1065 - 115}\,100 = 60\%,$$

corresponding to the moisture content of the solution ahead of the drier. We ignore the reduction in the moisture content of the solution by extraction of the product dust from the air stream.

Basing ourselves on the air velocity in the scrubber, u_{sc} = 1 m/sec, let us determine the diameter of the scrubber

$$D_{sc} = \sqrt{\frac{L_{sc} v_{sc}}{0{,}785 \cdot 3600\, u_{sc}}} = \sqrt{\frac{8853 \cdot 1{,}085}{0{,}785 \cdot 3600 \cdot 1}} = 1{,}84 \text{ м.}$$

The scrubber employs the solution in recirculation, on the calculation that the density of irrigation must be $A = 3$ t/m^2/hr.

The amount of solution atomized is

$$G_p = A\frac{\pi D_{c\kappa}^2}{4} = 3\,\frac{3{,}14 \cdot 1{,}84^2}{4} = 7{,}92 \text{ т/час} = 7920 \text{ kg/hr}$$

The moisture content of the solution ahead of the scrubber is

$$w_{sc} = \frac{G_1 w_1 + (G_p - G_1)\, w_1'}{G_p} = \frac{1065 \cdot 64{,}3 + (7920 - 1065)\, 60}{7920} = 60{,}7\%.$$

Let us mount 4 coarse-spray centrifugal nozzles in the scrubber. Atomization is at 3.0 atm excess pressure. Let us use a nozzle the dimensions of which assure a discharge coefficient, m, of 0.5, and determine the diameter of the discharge section of the nozzle.

$$\delta_\phi = \sqrt{\frac{G_p}{4 \cdot 0{,}785 \cdot 3600\, \mu \sqrt{2g\, \Delta p\, \rho'_p}}} =$$

$$= \sqrt{\frac{7920}{4 \cdot 0{,}785 \cdot 3600 \cdot 0{,}5 \sqrt{2 \cdot 9{,}81 \cdot 3 \cdot 10^4 \cdot 1100}}} = 0{,}74 \cdot 10^{-2} \text{ м} = 7{,}4 \text{ мм.}$$

The mean temperature differential between the air and the surface of evaporation of the drops of solution is

$$\Delta t_{co} = \frac{t'_{sc} - t'_{sc}}{2{,}3 \lg \dfrac{t'_{sc} - t'_{м}}{t'_{sc} - t'_{м}}} = \frac{93 - 62}{2{,}3 \lg \dfrac{93 - 49}{62 - 49}} = 25{,}5°,$$

in which t'_m is the temperature shown by a wet-bulb thermometer for the air in the scrubber, or 49°C.

The volumetric coefficient of heat exchange is

$$\alpha_v = 95 \cdot A^{0{,}82} = 95 \cdot 3^{0{,}82} = 235$$

The amount of heat transferred from the air to the atomized solution is

$$Q_{sc} = W_{sc}(595 + 0{,}47\, t'_{ck} - t'_{\mathit{\kappa}}) = 115\,(595 + 0{,}47 \cdot 62 - 49) = = 66\,000 \text{ kcal/hr}$$

The volume of the scrubber is

$$V_{sc} = \frac{Q_{sc}}{\alpha_v \, \Delta t_{cp}} = \frac{66\,000}{235 \cdot 25{,}5} \approx 11 \text{ м}^3.$$

The working height of the scrubber is

$$H_{sc} = \frac{V_{ck}}{F_{sc}} = \frac{11{,}0}{2{,}64} = 4{,}17 \text{ м}.$$

Analysis of the Gas Heater

Let us use the Stal'proyekt heater (needle-like tubes without outside needles). The air is heated by flue gases obtained by the burning of Moscow coal in a furnace with a horizontal fire grate and manual firing. The heater does not employ recirculation of the flue gases.

The elementary composition of the fuel is

$$W^p = 32{,}5\%;\ A^p = 23{,}6\%;\ S^p_\kappa = 2{,}6\%;\ C^p = 29{,}4\%;$$
$$H^p = 2{,}2\%;\ N^p = 0{,}6\%;\ O^p = 9{,}1\%;\ Q^p_\kappa = 2540 \text{ kcal/kg}$$

In accordance with the analysis by equations (III-19), (III-23), and (III-27), the maximum calorific value of this fuel is Q^p_B = 2871 kcal/kg; the amount of air theoretically required to burn one kilogram of fuel, L_0, is 3.86 kg/kg; and the amount of steam formed in burning one kilogram of fuel, L_n, is 0.523 kg/kg.

Ahead of the heater, the temperature of the mixture of fuel gases and air has to be t'_2, or 750°C. Then, by equation (III-30) the coefficient of excess air will be

$$\alpha = \frac{Q_{\text{в}}^{p}\eta_{m} + c_m t_m - \left(1 - \frac{9H^p + W^p + A^p}{100}\right)c_{c.г} t_{г}' - \frac{9H^p + W^p}{100} i_n}{L_0\left(c_{c.г} t_{г}' + \frac{i_n d_0}{1000} - I_0\right)} =$$

$$= \frac{2871\cdot 0,87 + 0,28\cdot 0 - \left(1 - \frac{9\cdot 2,2 + 32,5 + 23,6}{100}\right)0,26\cdot 750}{3,86\left(0,26\cdot 750 - \frac{964\cdot 1,47}{1000} + 1,53\right)} - \frac{\frac{9\cdot 2,2 + 32,5}{100}\,964}{3,86\cdot\left(0,26\cdot 750 + \frac{964\cdot 1,47}{1000} + 1,53\right)} = 2,64.$$

The amount of water vapor entering with the air is

$$L_{n.в} = \frac{\alpha L_0 d_0}{1000} = \frac{2,64\cdot 3,86\cdot 1,47}{1000} = 0,015$$

The amount of absolutely dry gases obtained by burning one kilogram of fuel is

$$L_{c.г} = 1 + \alpha L_0 - \frac{9H^p + W^p + A^p}{100} =$$

$$= 1 + 2,64\cdot 3,86 - \frac{9\cdot 2,2 + 32,5 + 23,6}{100} = 10,44 \text{ kg/kg}$$

The moisture content of the mixture of flue gases and air ahead of the heater, at $t_2 = 750°$, is

$$d_{cм} = \frac{1000\,(L_{n.в} + L_n)}{L_{c.г}} = \frac{1000\,(0,015 + 0,523)}{10,44} = 51,6 \text{ g/kg}$$

The process of heating the air is expressed, on diagram I-d by the line AB (Figure 77b). The amount of heat required to heat the air is

$$Q_{к} = L\,(I_1 - I_0) = 8050\,(73 + 1,53) = 600\,000$$

in which I_0 and I_1 represent the enthalpy of the air ahead of and after the heater, in kcal/kg.

This is the quantity of heat transmitted to the air from the mixture of flue gases and air.

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The process of cooling the air proceeds at a constant relative humidity, d_{cm} = 51.6 g/kg, from t'_2 = 750°C to t''_2 = 280°C, and is depicted on the I-d diagram (Figure 77b) by the Line B_1B_2.

The quantity of absolutely dry gases needed to heat the air is

$$L_2 = \frac{Q_K}{(I'_2 - I''_2)\eta_n} = \frac{600\,000}{0.9\,(289{,}5 - 119{,}5)} = 5550 \quad \text{kg/hr}$$

in which η_n is the efficiency of the heater, 0.9; and I'_2 and I''_2 are the enthalpies of the gas ahead of and after the heater, in kcal/kg.

The fuel consumption is

$$B = \frac{L_2}{L_{c.z}\eta_t} = \frac{5550}{10{,}41 \cdot 0{,}9} = 590 \quad \text{kg/hr}$$

in which η_m is the efficiency of the furnace, with allowance for mechanically and chemically incomplete burning, which is about 0.9.

The unit consumption of heat per volume of fuel per kilogram of moisture vaporized is

$$q = \frac{Q^p_n B}{W} = \frac{2540 \cdot 590}{665} = 2250 \quad \text{kcal/kg}$$

The unit consumption of heat per volume of air per kilogram of vaporized moisture, is

$$q' = \frac{L(I_1 - I_0)}{W} = \frac{8050\,(73 + 1{,}53)}{665} = 903 \quad \text{kcal/kg}$$

Analysis of the surface of the heater, and of the resistance along the course of the air and furnace gases is by the method generally employed in thermodynamics.

Furnace Analysis

The area of the surface of combustion, R_m, is

$$R_m = \frac{BQ^p_n}{\frac{Q}{R}} = \frac{590 \cdot 2540}{300\,000} = 5{,}0 \text{ м}^2,$$

in which Q/R is the load on the surface of combustion, or 300,000 kcal/m^2/hr.

The volume of furnace space is:

$$V_m = \frac{BQ^p_n}{\frac{Q}{V_m}} = \frac{590 \cdot 2540}{125\,000} = 12 \text{ м}^3,$$

in which Q/V_m is the load on the furnace volume, which is 125,000 kcal/m^3/hr.

The gas heater furnace is operated on natural draft, analysis of which is adduced in various sources, among them V. A. Volyntsev, et al., Zhelezobetonnye dymovye truby, proyektirovanie i vozvedenie (Design and Erection of Reinforced Concrete Smokestacks), Stroyuzdat, 1950.

Selection of Blowers

Selection of Furnace Blower

The blast air requires

$$L_a = \alpha_m L_0 B = 1{,}3 \cdot 3{,}86 \cdot 590 \approx 3000 \quad \text{kg/hr}$$

in which a_m is the coefficient of excess air delivered under the grate, and equivalent to 1.3.

Taking the resistance of the fuel layer at 60 mm water column, and that of the air ducts as 20 mm water column, let us determine the total resistance of the system at a temperature of 20°C:

$$\Delta p = \Delta p' \frac{273 + t_0}{273 + 20} = 80 \frac{273 - 10}{293} = 72 \text{ mm water column}$$

in which Dp' is the resistance of the system at -10°C, in mm water column.

On the basis of its characteristics (V_d = 2,300 m^3 per hour and Δ p = 72 mm water column), let us select a ventilator of series VRN No 4, in which n is 1,790 rpm and η_B = 0.64.

The consumption of electric power is

$$N_1 = \frac{V_d \Delta p'}{3600 \cdot 102\, \eta_B\, \eta_n} = \frac{2300 \cdot 80}{3600 \cdot 102 \cdot 0.64 \cdot 0.9} = 0.9 \text{ kw}$$

in which η_n is the efficiency of the drive which is 0.9.

Selection of Blower Delivering Air to Drier

The blower capacity is

$$V_1 = Lv_0 = 8050 \cdot 0.76 = 6120 \quad m^3/hr$$

in which v_0 is the specific air volume at t_0.

The resistance of the air filter is 20 mm water column, that of the heater 50 mm water column, and that of the air ducts 20 mm water column.

On the basis of its characteristics (V_1 = 6120 m^3/hr, and Δ p' = 81 mm water column, we choose a VRN No 5 blower, for which n is 1,730 rpm, and η_B is 0.63.

The consumption of electric power is

$$N_2 = \frac{V_1 \Delta p}{3600 \cdot 102\, \eta_B\, \eta_n} = \frac{6120 \cdot 90}{3600 \cdot 102 \cdot 0.63 \cdot 0.9} = 2.65 \text{ kw}$$

Selection of Blower to Remove Air from Drier

The capacity of this blower is

$$V_в = L_{ск} v'' = 8855 \cdot 1,18 = 10\,700 \quad m^3/hr$$

in which V" is the specific volume of the air at t'ск.

The resistance of the drier, cyclones, scrubber and air ducts, at their respective temperatures, are $\Delta p' = 120$ mm water column.

The resistance of the system at 20°C is

$$\Delta p = \Delta p' \frac{273 + t'_{ск}}{293} = 120 \frac{273 + 93}{293} = 152 \text{ mm water column}$$

Two ventilators were provided, due to considerations of engineering.

On the basis of its characteristics ($V'_B = 5350$ m³/hr, and $\Delta p = 152$ mm water column, we select a VRS No 4 blower, in which n is 1,620 rpm, and $\eta_B = 0.57$.

The power consumption by the two blowers is

$$N_в = \frac{2V'_в \Delta p'}{3600 \cdot 102\, \eta_в \eta_м} = \frac{2 \cdot 5350 \cdot 120}{3600 \cdot 102 \cdot 0,57 \cdot 0,9} = 6,85 \text{ kw}$$

[Pages 14-38]

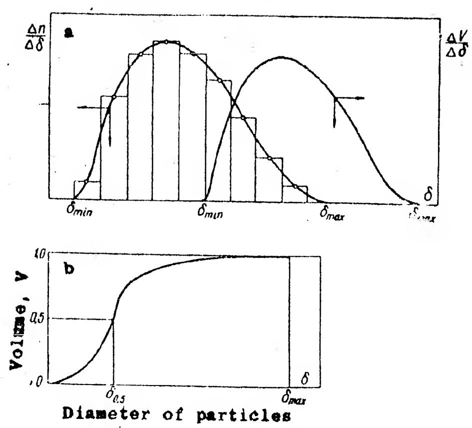

Figure 3. Curve of particle size distribution. a, distribution curves; b, integral distribution curve.

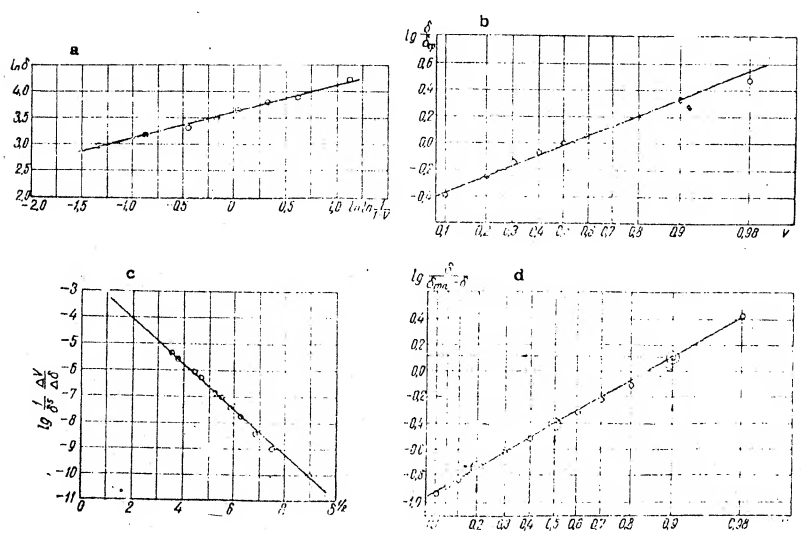

Figure 4. Particle diameter distribution curves. a, by Equation (II-10); b, by Equation (II-13); c, by Equations (II-16) and (II-13); d, by Equations (II-16) and (II-22).

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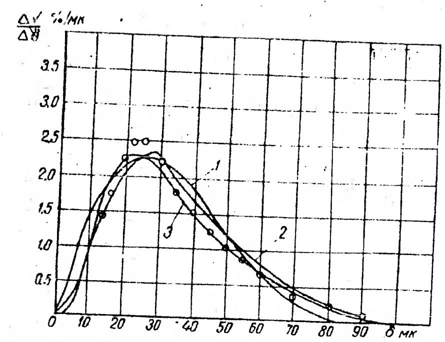

Figure 5. Distribution curves. 1, by Equation (II-10); 2, by Equation (II-13); 3, by Equation (II-16).

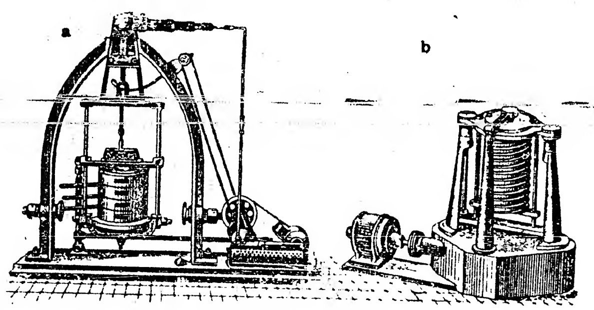

Figure 6. Screen sizing machines. a, with shaking screens; b, with rotating screens.

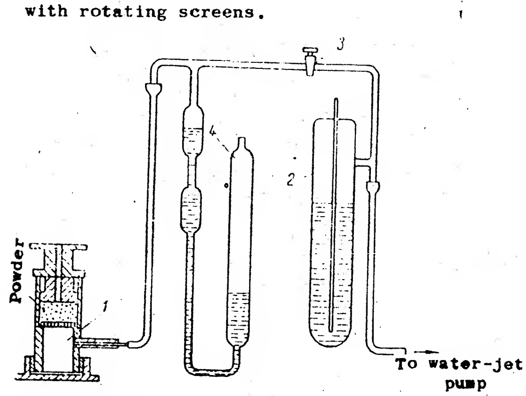

Figure 7. Tovarov's apparatus for determining surface area of particles of powder.

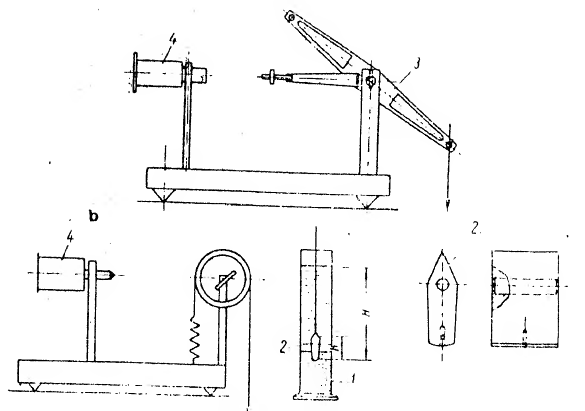

Figure 8. Figurovskiy-Margolin's apparatus for determining the dispersion of suspensions. a, sedimentometer with quadrant b, sedimentometer with spring.

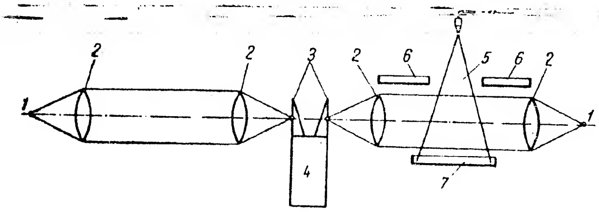

Figure 9. Abbreviated schematic of photometer.

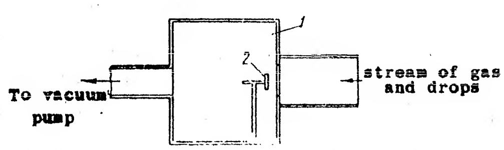

Figure 10. Abbreviated schematic of instrument for drop-size determination.

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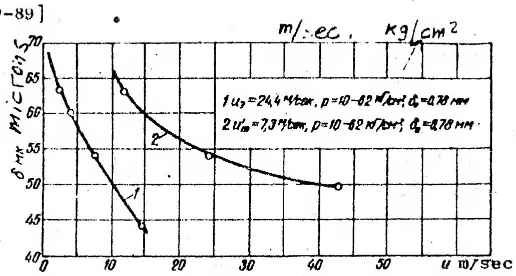

Figure 14. Effect of tangential (1) and axial (2) velocities on average diameter of drop of spray.

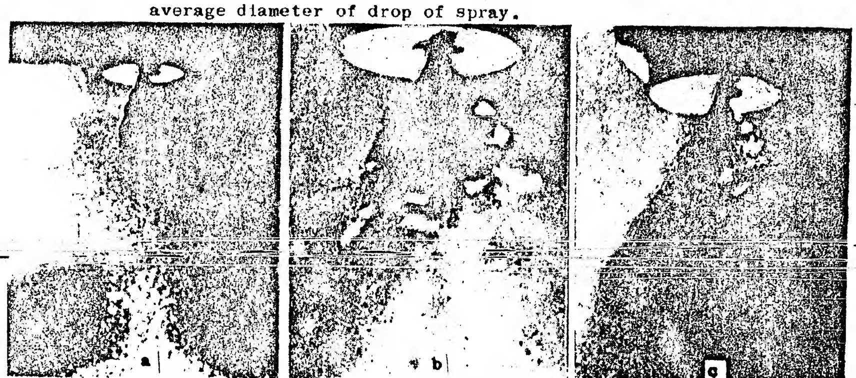

Figure 15. Spraying of water by mechanical nozzles. a, air pressure 1.5 atm excess pressure; b, 1.8 atm excess pressure; c, 10 atm excess pressure.

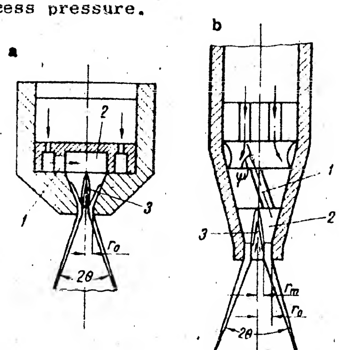

Figure 16. Schematics of mechanical nozzles. a, TsKKB nozzle; b, Grigor'yev nozzle.

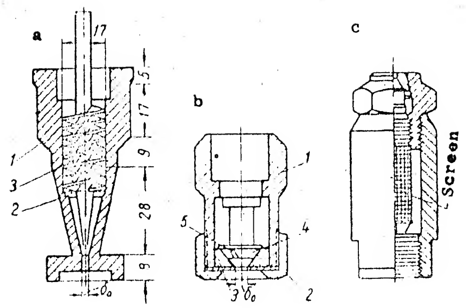

Figure 17. Mechanical nozzles. a, Kerting; b, Grigor'yev; c, Grigor'yev-type.

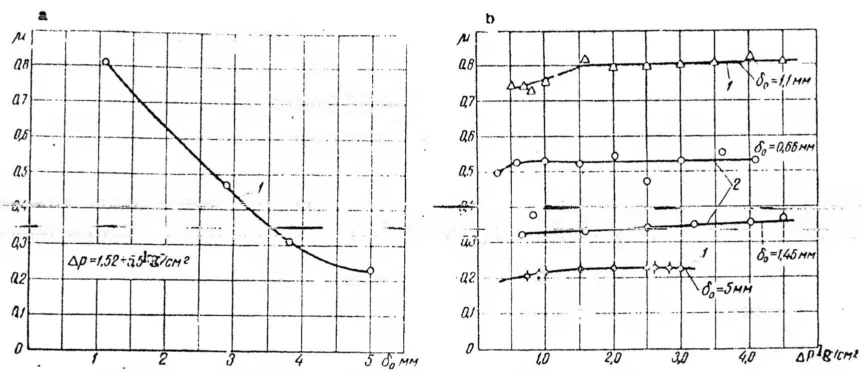

Figure 18. Discharge coefficient. 1, Kerting nozzle; 2, Grigor'yev nozzle.

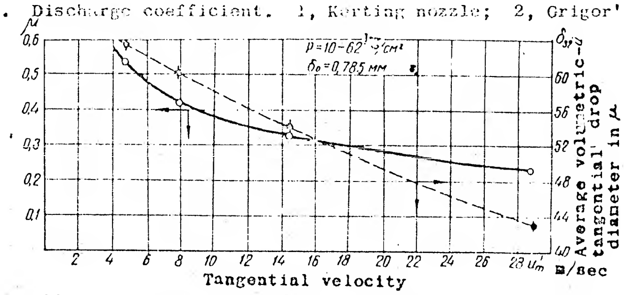

Figure 19. Discharge coefficient of Grigor'yev-type nozzle.

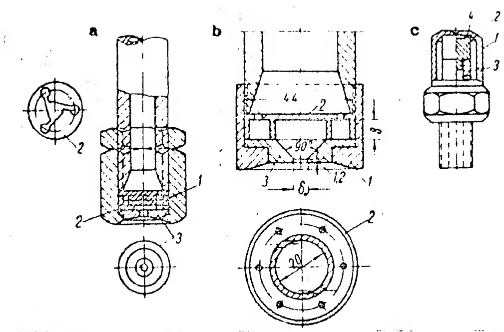

Figure 20. Mechanical nozzles. a, TsKKB system; b, TsKKB type; c, low-output.

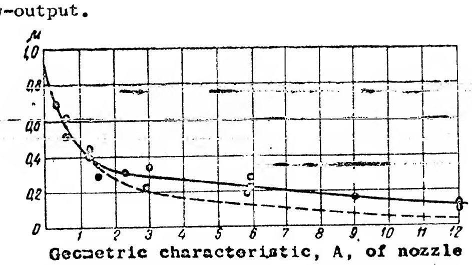

Figure 21. Relation of discharge coefficient of TsKKB-type nozzle to geometrical characteristic, A .

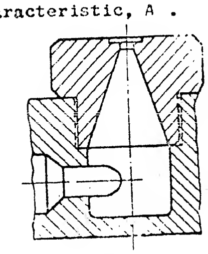

Figure 22. Centrifugal nozzle.

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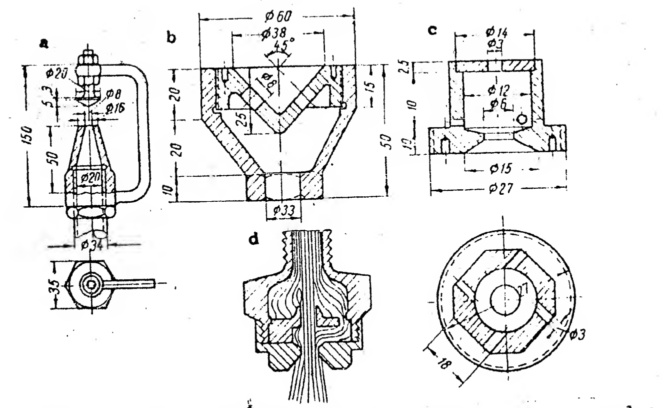

Figure 23. Mechanical nozzles for coarse dispersion. a, b, nozzles developed by VTI; c, d, coarse-dispersion nozzles.

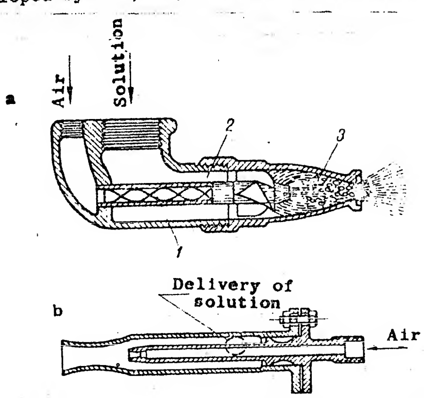

Figure 24. Pneumatic internal-mixing nozzles. a, with contracting mouth; b, with expanding mouth.

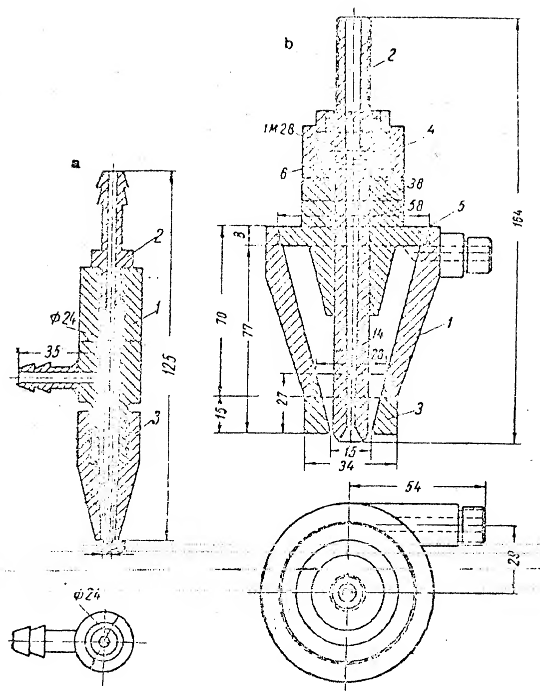

Figure 25. Pneumatic nozzles with external mixing. a, with radial compressed-air intake; b, with tangential compressed-air intake; 1, casing; 2, insert; 3, tip; 4, attaching screw; 5, cover; 6, gasket.

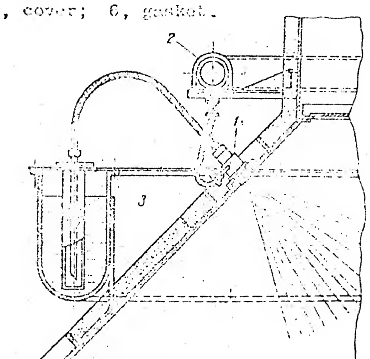

Figure 26. Schematic of solution feed to nozzle. 1, nozzle; 2, compressed-air line; 3, container of solution.

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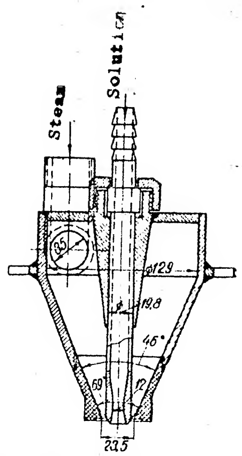

Figure 27. 650 kg/hr pressure nozzle.

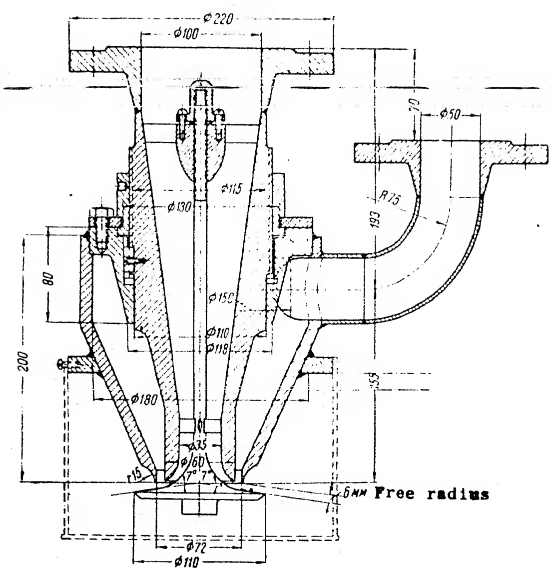

Figure 28. Platter-type pressure nozzle.

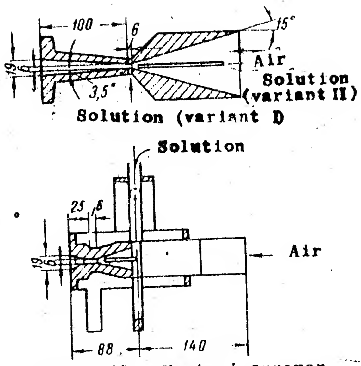

Figure 29. Venturi sprayer.

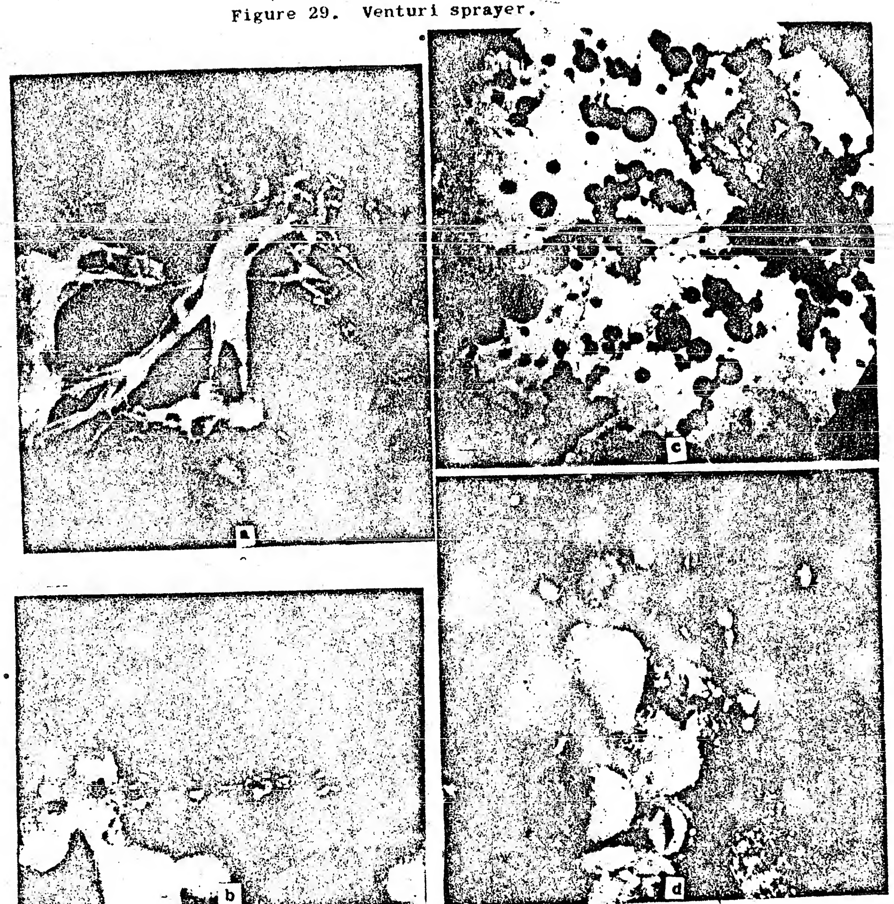

Figure 30. Microphotograph of dry bone glue (enlarged 160 times).

a, b, pressure spraying; c, pressure spraying; d, spraying with mechanical nozzles.

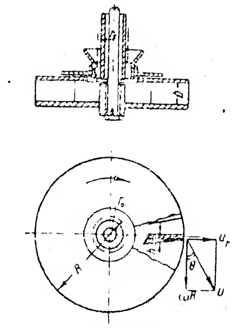

Figure 31. Diagram of centrifugal disk with radial blades.

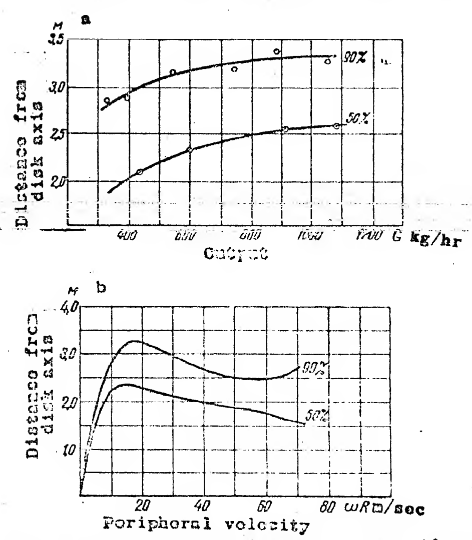

Figure 32. Graph of distribution of spray in centrifugal-disk spraying.

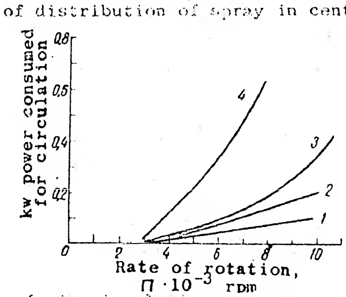

Figure 33. Effect of air circulation on power consumption. 1, disk 7, 64-mm radius; 2, 4, disk 6, [illegible]-mm radius; 3, disk 5, 76-mm radius.

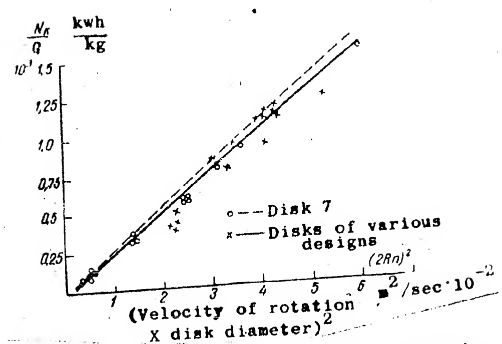

Figure 34. Unit consumption of power in spraying.

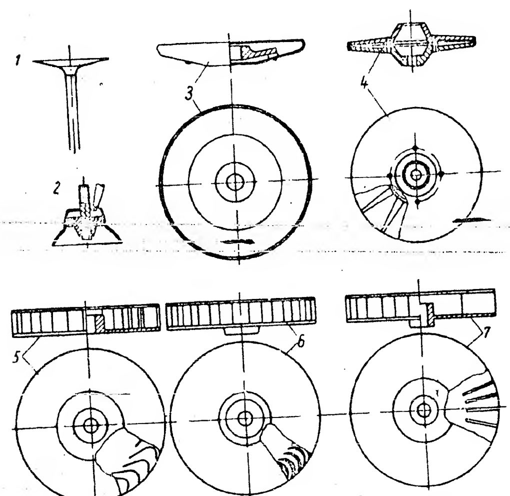

Figure 35. Solid disks for spraying of solutions.

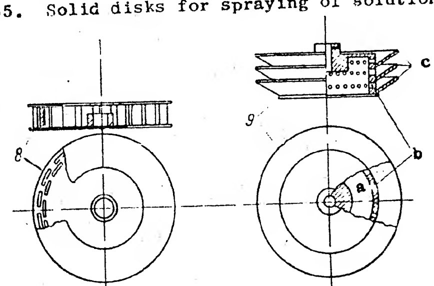

Figure 36. Disks for spraying of solutions.

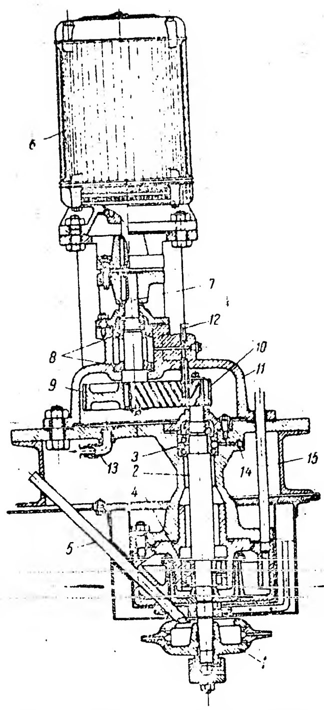

Figure 37. Spray-disk transmission.

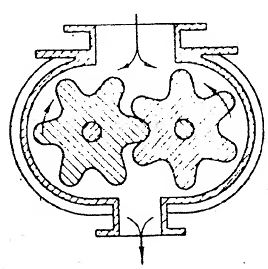

Figure 38. Gear-driven feed.

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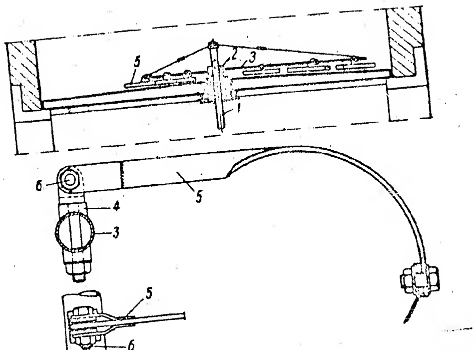


Figure 47. Scraper.

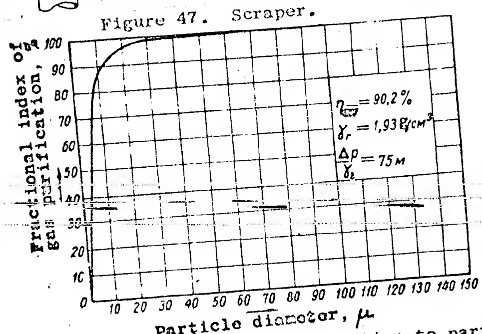
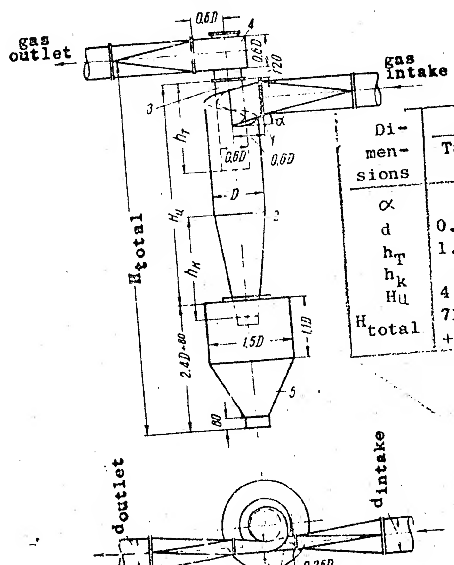


Figure 48. Ratio of coefficient of gas purification to particle diameter.



Dimensions	Cyclone Model TsN-15	TsN-15u	TsN-24	TsN-11
α	15°	15°	24°	11°
d	0.66D	0.66D	1.11D	0.48D
h_T	1.74D	1.5D	2.11D	1.56D
h_k	2D	1.5D	1.75D	2D
Hu	4.3D	3.1D	4D	4.1D
H_{total}	7D +200	5.8D +200	6.7D +200	6.8D +200

Figure 49. [Sc]hematic of NIIOGAZ cyclone.

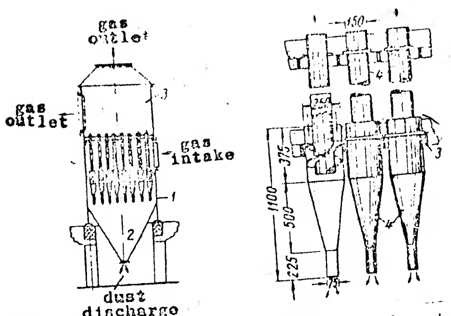


Figure 50. Schematic of TsG-1 multicyclones. 1, housing; 2, hopper; 3, purified-gas chamber; 4, cyclone units.

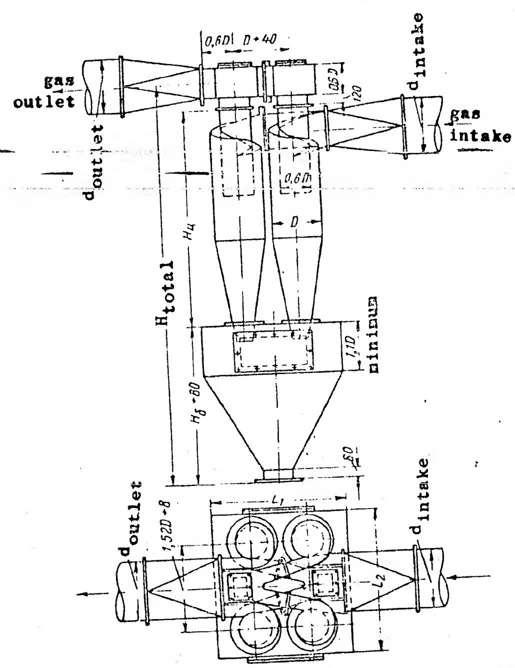


Figure 51. NIIOGAZ cyclone battery.

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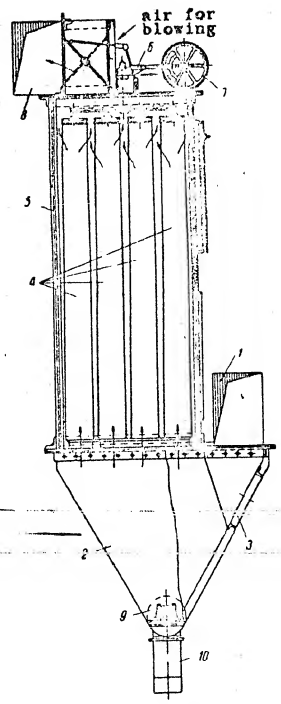

Figure 52. Cloth sleeve filter. 1, dust-laden air line; 2, hopper; 3, hopper hatch; 4, cloth sleeves; 5, housing; 6, agitator and blower; 7, agitator-blower flywheel; 8, filtered-air line; 9, conveyor; 10, outflow and seal.

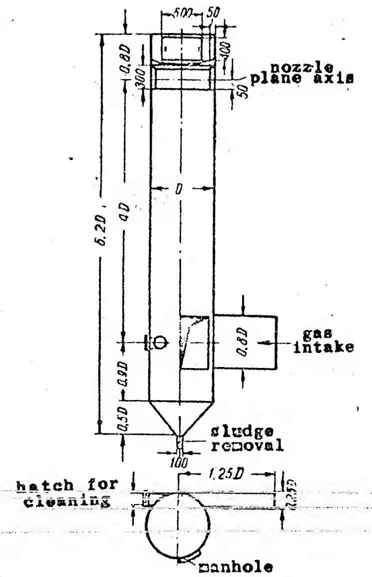

Figure 53. VTI centrifugal scrubber.

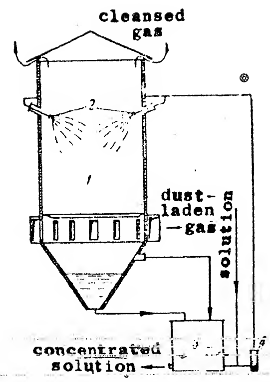

Figure 54. Schematic of scrubber. 1, scrubber; 2, mechanical nozzles; 3, tank; 4, pump.

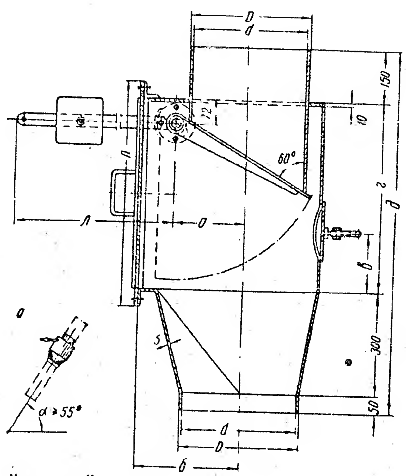

Figure 55. "Winker" counterweight valve with gate in closed position. a, winker installed in inclined position.

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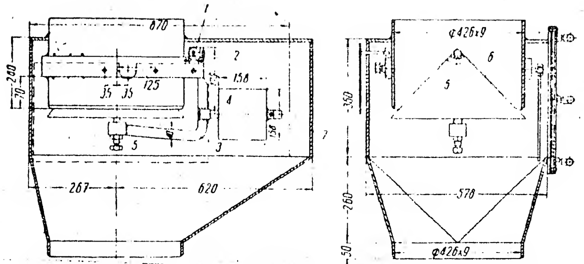

Figure 56. VTI winker with radial dust descent. 1, axle; 2, knife-edges; 3, beam arm; 4, counterweight; 5, pin; 6, cone valve; 7, casing.

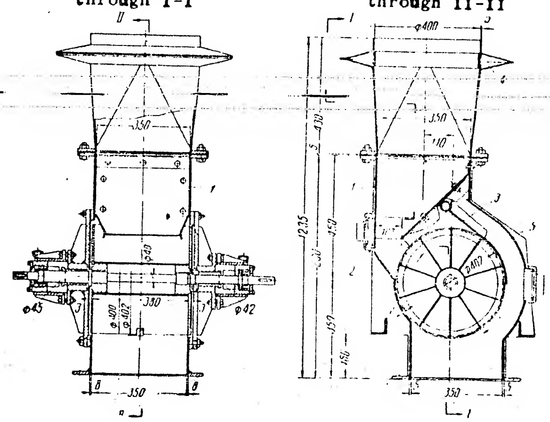

Figure 57. VTI vane seal. 1, mounting section; 2, seal rotor; 3, sealing apron; 4, compensator; 5, housing.

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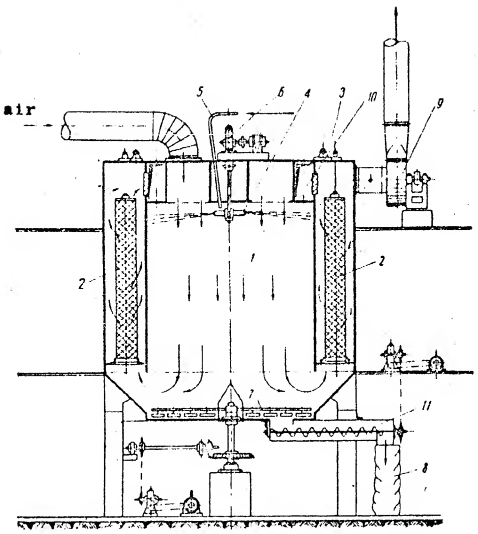

Figure 63. Schematic of drier with centrifugal atomization of solution. 1, drying chamber; 2, cloth sleeve filters; 3, agitator; 4, disk sprayer; 5, delivery of solution; 6, disk drive; 7, scrapers; 8, discharge of product; 9, blower; 10, duct for used air; 11, worm conveyor.

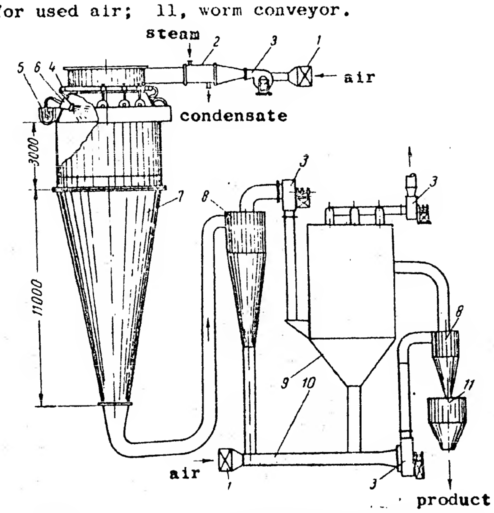

Figure 64. Schematic of drier with pneumatic atomization of solution. 1, air filters; 2, steam heater for air; 3, blowers; 4,

compressed air line; 5, solution feed tank; 6, pressure nozzle; 7, drying chamber; 8, cyclones; 9, sleeve filter; 10, transport tube; 11, bin.

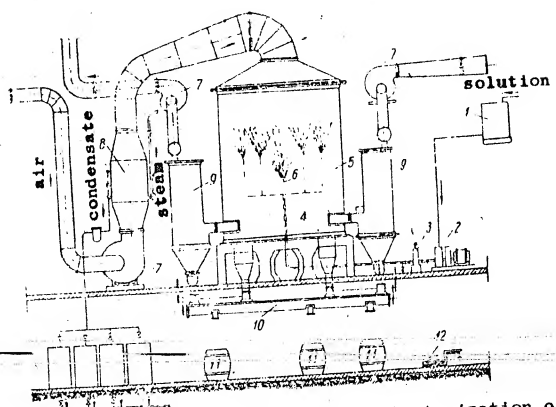

Figure 65. Schematic of drier with mechanical atomization of solution.

1, tank; 2, pump; 3, pressure equalizer; 4, support; 5, drying chamber; 6, mechanical nozzles; 7, blowers; 8, steam heater; 9, cloth filters; 10, worm conveyor; 11, containers; 12, scales.

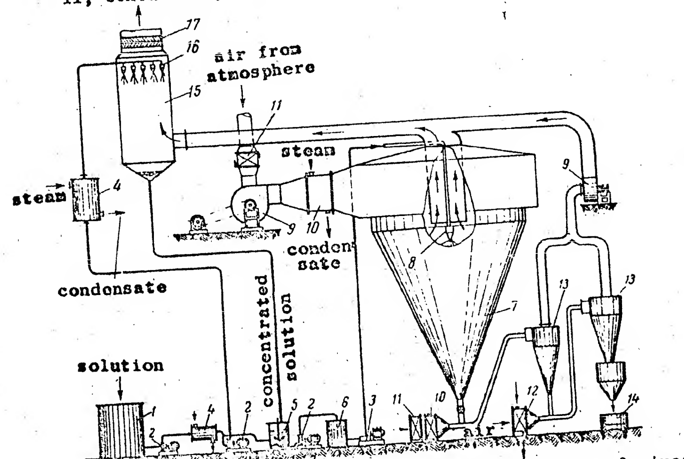

Figure 66. Schematic of spray drier operating on principle of mixed

current of air and solution. 1, tank; 2, pumps; 3, high pressure pump; 4, heat exchanger; 5, tank with sifter; 6, deaerator; 7, drying chamber; 8, mechanical nozzles; 9, blowers; 10, steam heaters; 11, filters; 12, air cooler; 13, cyclones; 14, packing machine; 15, scrubber; 16, mechanical coarse-spray nozzles; 17, drop trap.

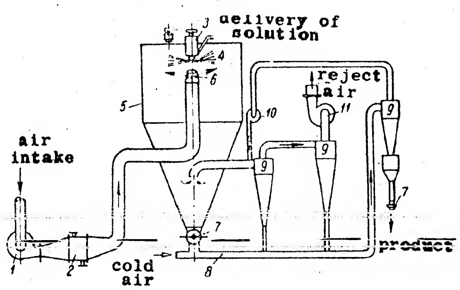

Figure 67. Schematic of spray drier with purification of gases in cyclones, and cooling of the product. 1, intake blower; 2, air heater; 3, drive; 4, disk; 5, drying chamber; 6, hot air distributor; 7, seal valve; 8, air duct; 9, cyclones; 10, blower for pneumatic transport; 11, exhaust fan.

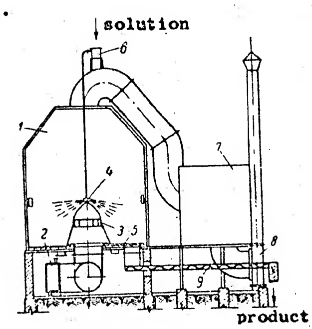

Figure 68. Schematic of spray drier with centrifugal atomization of solution. 1, drying chamber; 2, steam heater; 3, distributing manifold; 4, centrifugal disk; 5, scrapers; 6, tank; 7, sleeve filter; 8, blower; 9, worm conveyor.

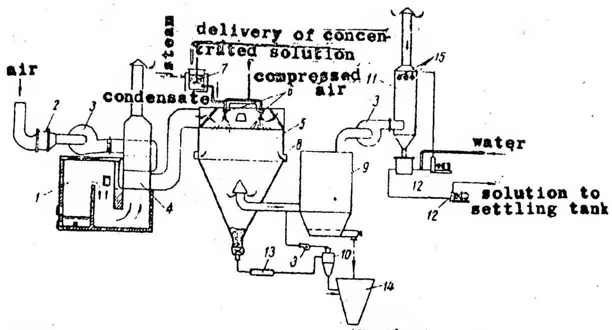

Figure 69. Schematic of spray drier with gas air-heater and scrubber. 1, furnace; 2, air filter; 3, blower; 4, gas heater; 5, drying chamber; 6, pneumatic nozzles; 7, tank with steam heating and stirrer; 8, cold air intake; 9, cloth filter; 10, cyclone; 11, centrifugal disk; 12, pumps; 13, grinding mill; 14, bin; 15, mechanical nozzles.

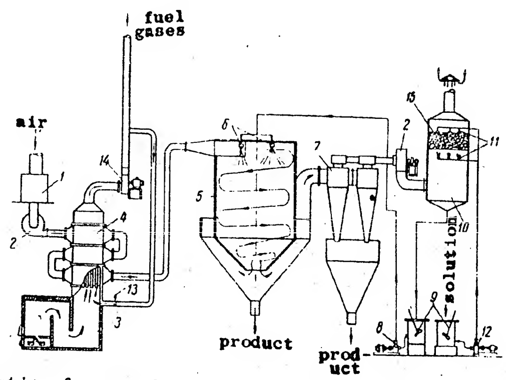

Figure 70. Schematic of spray drier. 1, filter; 2, blowers; 3, furnace; 4, gas air-heater; 5, drying chamber; 6, mechanical nozzles; 7, battery cyclone; 8, high-pressure nozzle; 9, tanks with stirrers; 10, scrubber; 11, mechanical coarse-spray nozzles; 12, centrifugal pump; 13, gate; 14, flue gas pump; 15, packing.

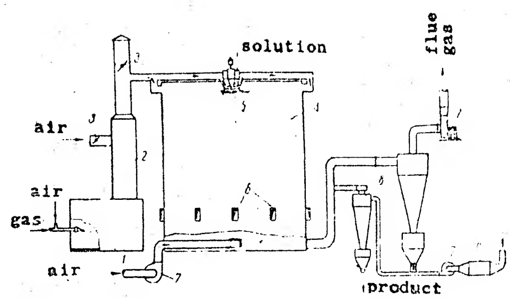

Figure 71. Schematic of spray drier using furnace gases. 1, gas furnace; 2, mixing chamber; 3, damper; 4, drying chamber; 5, centrifugal disk; 6, windows; 7, blowers; 8, cyclones; 9, air cooler.

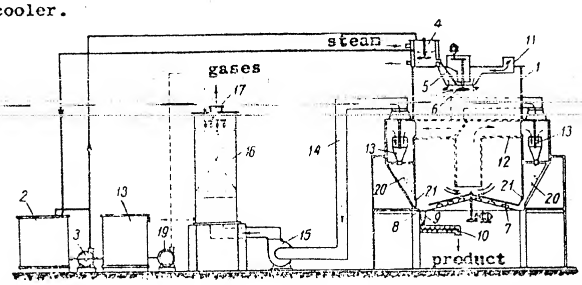

Figure 72. Schematic of spray drier for dye suspensions. 1, drying chamber; 2, 18, tanks; 3, 19, centrifugal pumps; 4, tank with stirrer; 5, pipe; 6, atomizing disk; 7, scrapers; 8, discharge hole; 9, gravity flow; 10, worm conveyor; 11, hatch; 12, air ducts; 13, battery cyclones; 14, common air duct; 15, blower; 16, scrubber; 17, gas escape; 20, bins; 21, gates.

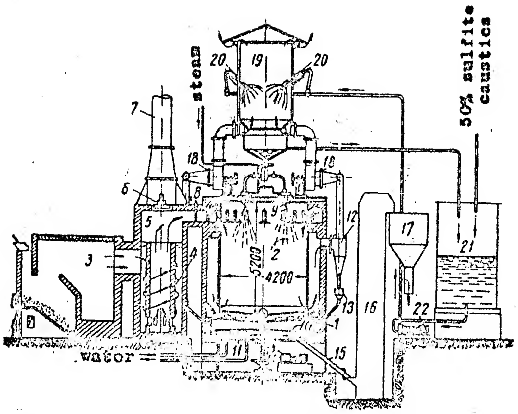

Figure 73. Schematic of VTI spray driers for sulfite caustics. 1, tower; 2, drying chamber; 3, furnace; 4, spark-retaining cyclone; 5, mixing chamber; 6, valve; 7, flue; 8, damper; 9, pressure nozzles; 10, scrapers; 11, cooler; 12, cyclone; 13, winker-valve; 14, drive; 15, gravity discharge; 16, elevator; 17, bunker; 18, blowers; 19, scrubber; 20, mechanical nozzles; 21, tank; 22, gear pump.

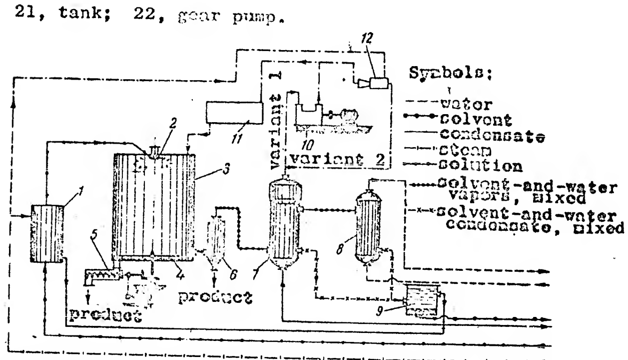

Figure 74. Sprayer using superheated steam for drying. 1, heat exchanger; 2, disk; 3, drying chamber; 4, scrapers; 5, worm conveyor; 6, cyclone; 7, 8, tubular heat-exchangers; 9, settling tank; 10, turbine compressor; 11, superheater; 12, steam-jet compressor.

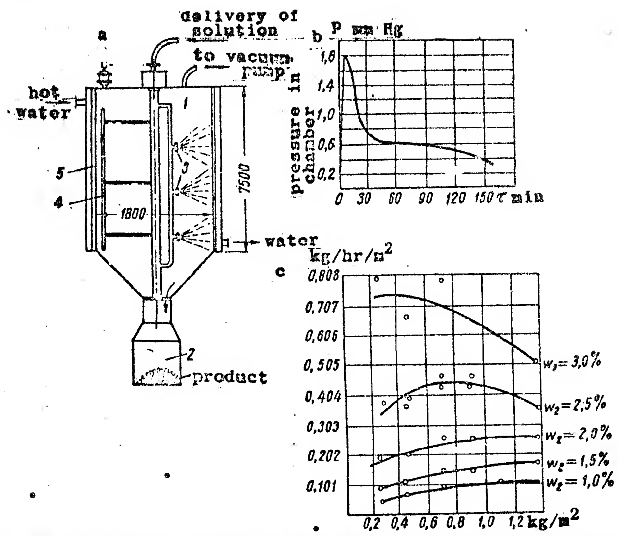

Figure 75. Schematic of vacuum-spraying ~~drier~~. a, schematic of drier: 1, chamber; 2, bin; 3, nozzles; 4, scrapers; 5, water jacket; b, change in pressure in chamber during drying process; c, relationships between intensity of drying process and terminal moisture content of product, and load on surface of chamber.

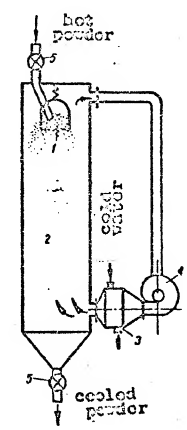

Figure 76. Schematic of cooler. 1, platter; 2, chamber; 3, heat exchanger; 4, blower; 5, seals.

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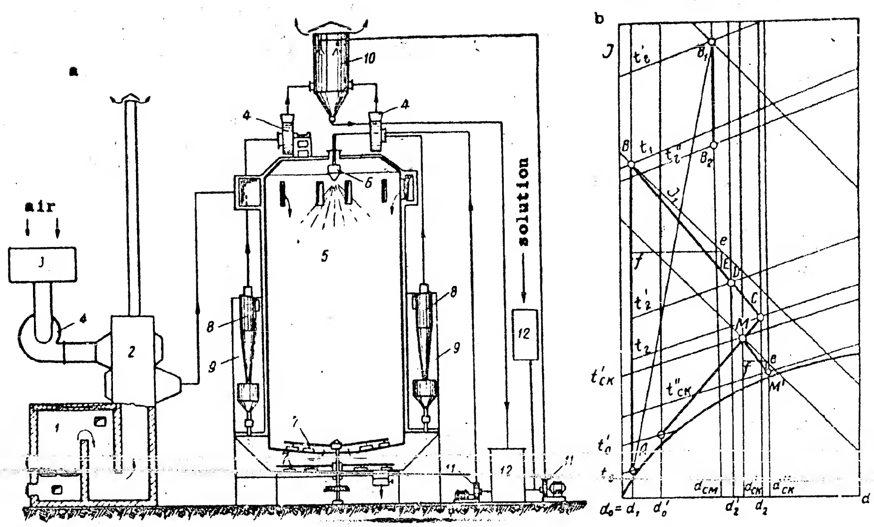

Figure 77. Schematic of spray drier. a, drier: 1, furnace; 2, air heater; 3, filter; 4, blowers; 5, drying chamber; 6, mechanical nozzle; 7, scrapers; 8, cyclones; 9, risers; 10, scrubber; 11, pumps; 12, tanks; b, plotting of processes on I-d diagram.

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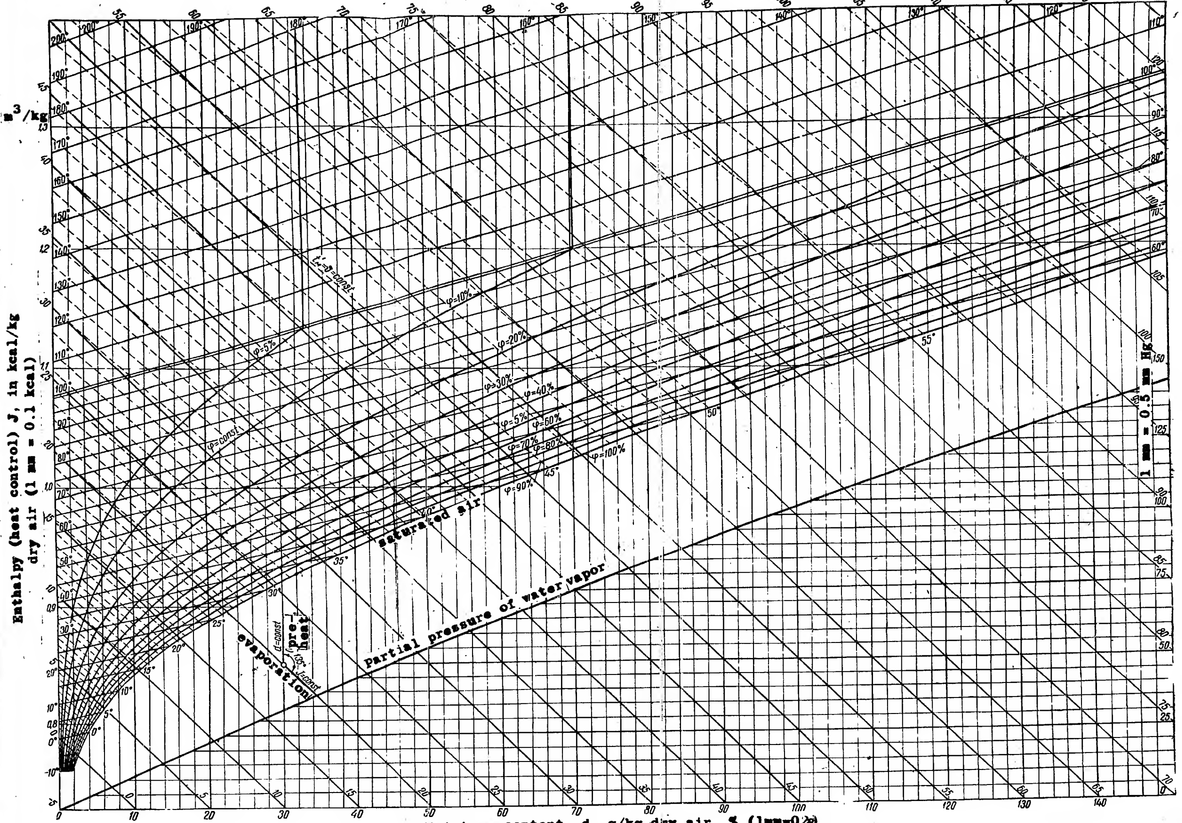
Appendix

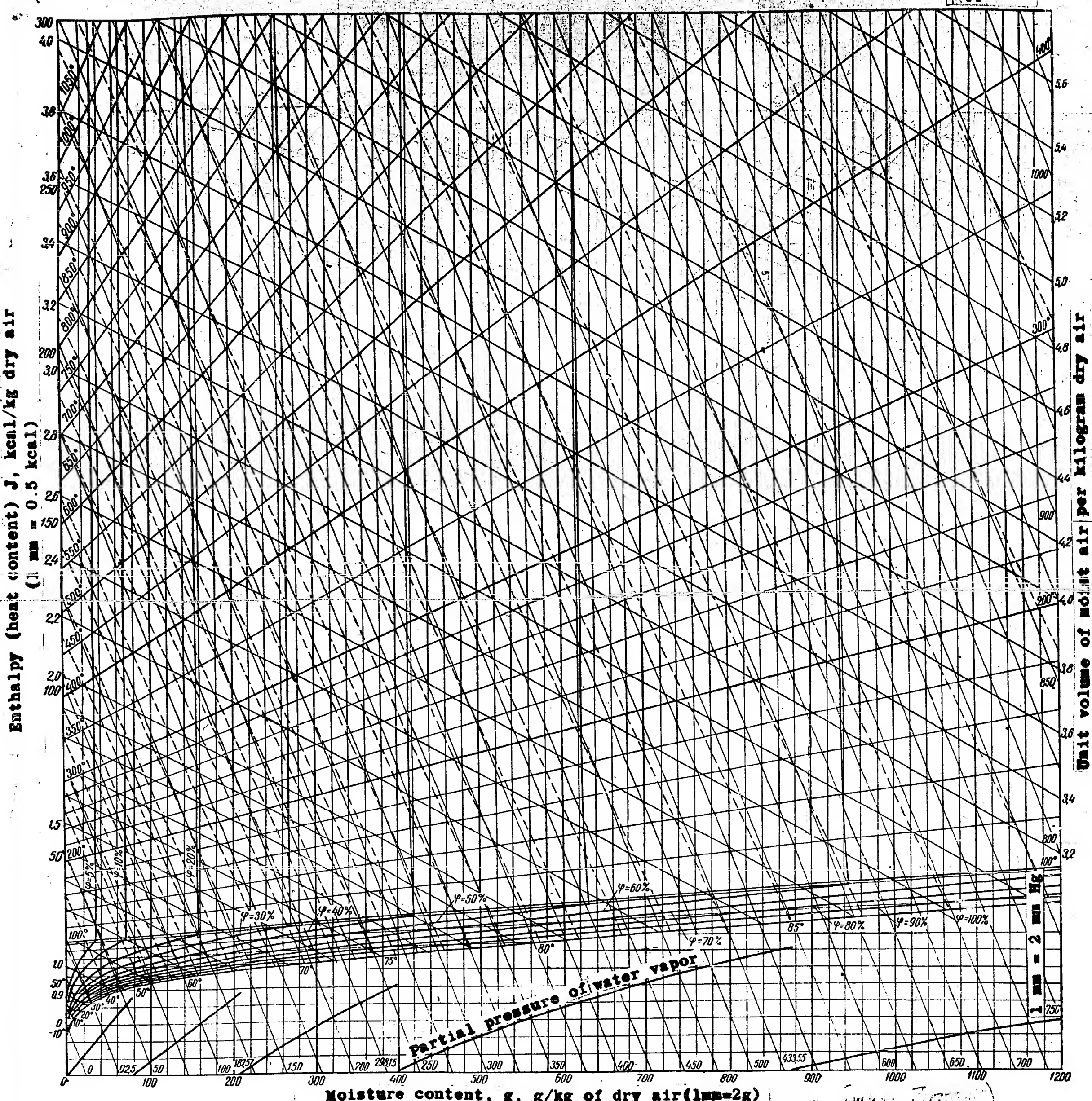


Зак. 1484

I-d diagram of moist air at 745 mm Hg per kilogram dry air content

Drying Laboratory of F. E. Dzerzhinskiy, VTI

Appendix



I-d diagram of moist air at 745 mm Hg per kilogram of dry air content

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